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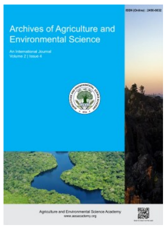

ORIGINAL RESEARCH ARTICLE

Integrated nutrient management for watermelon (*Citrullus lanatus* Thunb) cultivation in Rapti riverbed, Dang, Nepal

Poonam Sapkota[1*], **C.P. Shriwastav**[2], **Deepesh Dubey**[3] **and Bina Dhakal**[4]

[1]Assistant Professor, Department of Soil Science and Agri-engineering, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[2]Professor, Department of Soil Science and Agri-engineering, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[3]Department of Entomology, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[4]Department of Agronomy, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[*]Corresponding author's E-mail: poonamsapkota@afu.edu.np

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ABSTRACT

A field experiment was conducted at riverbed of Rapti River, Dang, Nepal from January to June, 2019 to assess the integrated nutrients management (INM) for watermelon cultivation at riverbed. The experiment was laid out in Randomized Complete Block Design with three replications and eight treatments (compost manure + chemical fertilizer, vermicompost + chemical fertilizer, neem seedcake powder+ chemical fertilizer, poultry manure+ chemical fertilizer, cattle manure+ chemical fertilizer, 100% from chemical fertilizer alone, control, and farmers practice)."Mastana" variety of watermelon was used for evaluating various combination of organic and inorganic fertilizer for yield, nutrient uptake and residual soil nutrient status. Among these treatments, neem seedcake powder (55 N $kgha^{-1}$) + N, P_2O, K_2O (55:40:40 $kgha^{-1}$) from inorganic fertilizer was better with growth parameters such as vine length, number of branches, number of leaves and yield parameters like fruit weight/plant and yield (tha^{-1}) than other treatments and significantly superior to control plot. Effect of INM on soil parameters like soil pH, total nitrogen (%), available phosphorus ($kgha^{-1}$) and available potassium ($kgha^{-1}$) at 0-20 and 20-50 cm depth and organic manure (%) at soil depth 20-50 cm were non-significant. The organic manure content at 0-20 cm depth was highest when neem seedcake powder+ chemical fertilizer was applied which was statistically similar with other treatments of INM but significantly higher than full dose of NPK from chemical fertilizer and control. Therefore, integration of neem seedcake powder (55N $kgha^{-1}$) with chemical fertilizer NPK (55: 40: 40 $kgha^{-1}$) would be best fitted for watermelon, in riverbed cultivation.

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INTRODUCTION

Watermelon (*Citrullus lanatus* [Thunb.] Matsum. and Nakai, is non-climacteric pepo fruit belonging to the Cucurbitaceae family. It is herbaceous creeping plant cultivated for its fruit and vegetative parts (Schippers, 2002; Asafa *et al*., 2022). It is most widely cultivated in the tropical and subtropical climates (Huh *et al*., 2014). Watermelon is considered as vegetable in Nepal and grown in an area of 2,473 ha producing 52,550 mt of watermelon annually with productivity of 21.25tha^{-1}(MoAD, 2022). Dang is one of the major watermelon cultivating area of the country covering an area of 17 ha with productivity 11.23 tha^{-1} of watermelon annually (MoAD, 2023). Watermelon contains high amount of vitamin C, vitamin A, vitamin B6, lycopene, carbohydrates, antioxidants, amino acids and anti-carcinogenic compound found in red flesh watermelon (Arora, 2024; Asafa *et al*., 2022). The fruit can be served fresh in fruit salads, cooked and used as confectionary. As the popularity and demand of watermelon is increasing rapidly but the present production of the country is unable to meet the market demand. So, the production of watermelon needs to be increased in various possible ways. Production is directly related to nutrients status of soil where it is cultivated. Combined use of manures and synthetic fertilizers can be a better way to maintain soil nutrient status, improve soil physical properties (bulk density, porosity, compaction, moisture), chemical properties and to promote sustainability in crop production (Paul & Mannan, 2006). Integrated nutrient management might offer a more sustainable production of watermelon as the different nutrient sources complement one another (Kumar, 2016; Chopra *et al.*, 2017). It was found that the total yields of watermelon (crimson sweet variety) increases by combine use of organic manure (Aguyoh *et al.*, 2010; Asafa *et al.*, 2022). Although some studies have been conducted to determine the combined effect of mineral (inorganic) and organic fertilizers on crop production, very few studies have been conducted on watermelon production in this regard.

Watermelon prefers well drained sandy soil. Sandy river basins area deposited with alluvial soil can be best utilized for watermelon production. The major crops grown in the river beds are cucurbits like water melon, cucumber, pumpkin, bottle gourd, bitter gourd, summer squash, and sponge gourd because they can tolerate harsh environment condition and due to their long tap root system (Kumari *et al.*, 2018). Riverbed farming is a source of income to landless, marginal poor households which help to utilize unused land and improve the socio-economic status of poor farmers (ICIMOD, 2013) and also helps in maintaining food security of Terai region of Nepal. As the soil is sandy in riverbed, integrated nutrient management would be a better option to increase production and maintenance of soil fertility. Though practice of cucurbit cultivation on riverbed is raising nowadays in Nepal, its productivity is not satisfactory due to lack of adequate knowledge regarding cultivation practices such as types, dose of fertilizers, appropriate time for irrigation, weed, insect, pest and disease management etc. The production of watermelon in Nepal is requisite to increase for meeting its market demand. Hence, the study, research and extension work regarding its cultivation practices and nutrient management in riverbed seems obligatory. Besides, to increase the production of watermelon, we can adopt an integrated nutrient management system. Nutrient management in riverbed farming is quite difficult as the soil is coarse textured and there is more chance of loss of nutrient by volatilization and leaching. Combination of rational use of organic manures and chemical fertilizers is essential for maximum yield and quality of any crop, and for maintenance of soil fertility (Chopra *et al.*, 2017). However, such information is lacking for cultivation of watermelon in riverbed of Dang even in Nepal and hence a field experiment was conducted to select the most suitable organic manure integration with chemical fertilizer for maximum yield of watermelon var. "Mastana" and assess their effect on soil physio-chemical properties.

MATERIALS AND METHODS

The research was carried out to formulate the effective integrated nutrient management option for watermelon cultivation in riverbed farming at Rapti riverbed, Bagarapur Ward no. 06, Dang, Nepal during January to June 2019. The experimental site was located at an elevation of 250 meter above sea level in the inner Terai region of Nepal. This research field was located in fallow riverbed with almost plain land having rich sandy soil texture. No crops were grown previously throughout the year, and it was completely bare land. The experimental design was Randomized Complete Block Design (RCBD), comprising of eight treatments with three replications. Individual plot size comprised of 8 m × 4 m (32 m^2), row to row spacing of 2m and plant to plant spacing 1m, each plot with 4 rows and 4 plants in each row taking 6 sample plants for data recording. The total plot size was 71m × 16m (1136m^2). "Mastana" variety of watermelon was selected and sown in prepared research field on last week of January. The recommended dose of watermelon is 10 tons of compost manure and 60: 40: 40 NPK kg ha^{-1}(MoAD, 2023). Total nitrogen in 10t compost manure was calculated and found 50 kg nitrogen. After analysis of the primary nutrients of the organic manures, the rate of manure was fixed assuming that single or integrated source provides 110 kg N per hectare as a reference value. Thus, the final fertilizer dose was taken as 110: 40:40 NPK kg ha^{-1} in which half of doses were provided from organic source and half from inorganic fertilizers as treatments.

Treatments details

The experimental field was thoroughly ploughed, levelled and all the weeds were removed. After field preparation, field layout was done in RCBD. Then pits were made each with dimensions 50cm× 50cm×50 cm. Three seeds were directly sown on each

Treatments	Treatments details
T_1	Compost manure (55 N, kgha^{-1}) + chemical fertilizer (55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_2	Vermi-compost manure (55 N, kgha^{-1}) + chemical fertilizer (55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_3	Neem seed cake Powder (55 N, kgha^{-1}) + chemical fertilizer (55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_4	Poultry manure (55 N, kgha^{-1}) + chemical fertilizer (55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_5	Cattle manure (55 N, kgha^{-1}) + chemical fertilizer (55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_6	Full Dose of N, P_2O_5 K_2O from chemical fertilizer (110:40:40 N, P_2O_5, K_2O kgha^{-1})
T_7	Control (Only chemical fertilizer 55:40:40 N, P_2O_5, K_2O kgha^{-1})
T_8	Farmers practice (Cattle manure (2.7 tha^{-1}) + chemical fertilizer (50:30:30 N, P_2O_5, K_2O kgha^{-1})

spot at a depth of 2-3 cm for germination assurance. One seedling per pit was maintained 20 days after germination. The total numbers of plant stand per plot and in the whole experiment there were 16 and 384 plants respectively. The 50% nitrogen was applied from organic source during basal dose and 50% of nitrogen was applied from chemical source urea, during top dressing except in T_6 where chemical source of nitrogen, urea was applied during basal dose as well as during top dressing. Total compost manure, vermicompost manure, cattle manure, poultry manure, 50% nitrogen from urea and whole P_2O5 and K_2O from SSP, MOP were applied as basal dose during land preparation and the remaining half dose of nitrogen during top dressing. Straw mulching was used in all plots to minimize the moisture loss. Cultural practices in fields like irrigation, weed management, and pest control were done as per the crop requirements. Watermelons were harvested at mature stage on different period from 9th May to 13th June 2019. Six random plants from each plot were taken for data collection, during the crop growing period and after harvesting. Growth parameters; emergence, vine length, number of leaves, number of branches per plant and yield parameters; days to flowering, number of fruits, the average weight of fruit (kg), yield (mt ha-1) were recorded during crop growing period and after harvest. Data entry and tabulation were done on MS Excel and data analysis was done using Gen-STAT 18th edition software. The effects of integrated nutrients management on measured variables were tested with analysis of variance (ANOVA). The means were compared using DMRT at a 5% level of significance.

RESULTS AND DISCUSSION

Effects of integrated nutrients management on watermelon plant parameters

During the study, vine length, leaf numbers and number of branches of watermelon were significantly influenced by the application of organic and inorganic fertilizers in an integrated manner where as days to seed germination and 50% flowering of watermelon were influenced non-significantly among the treatments (Tables 1, 2; Figure 1). The highest vine length, leaf numbers and number of branches of watermelon and earlier seed germination and 50% flowering was obtained from the application of neem seed cake powder+ chemical fertilizer which was also statistically similar with poultry manure + chemical fertilizer and cattle manure+ chemical fertilizer. Neem seed cake being the rich source of macro and micronutrients, having low C:N ratio supplies nutrients continuously to the soil and plants that might have improves soil properties and plant growth. Eifediyi *et al.* (2017) had also reported that the tallest plants were observed with combined application of NPK fertilizer and the Neem Seed Cake (NSC) amendment. The combined nutrients application ensured all round nutrient availability to the crop; the inorganic components were readily available and hence absorbed for early crop growth and development, while the organic components of the NSC were released slowly after mineralization thereby making nutrients available for the development of the crop. Neem seed cake mixed with urea fertilizer significantly improves efficiency of fertilizer utilization in crop production by gradual release of nitrogen to crops thereby increasing the fertility of the soil (Thakur *et al.*, 2020).

The maximum number of fruits per plant, average fruit weight, fruit weight per plant and total yield per hectare were obtained

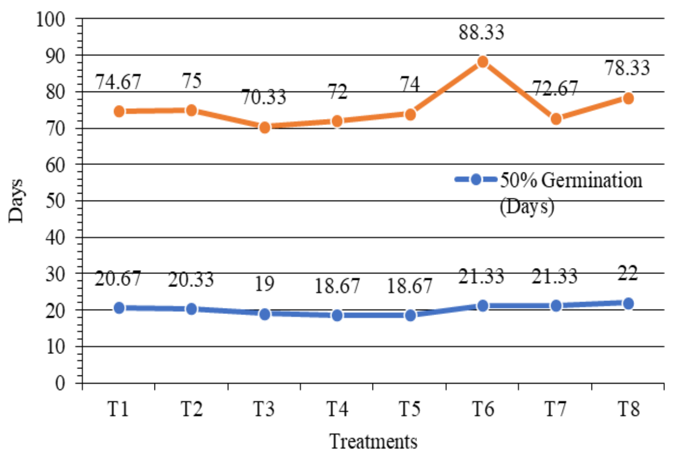

Figure 1. *Effects of integrated nutrients management on days of germination and 50% flowering of watermelon at Rapti riverbed, Dang, Nepal.*

Table 1. Effects of integrated nutrients management on vine length of watermelon at Rapti riverbed, Dang, Nepal.

Treatments	Vine length (cm)			
	30 DAS	45 DAS	60 DAS	75 DAS
T_1	5.97^{bc}	50.76^{bc}	126.4^{ab}	160.5^{c}
T_2	7.56^{b}	54.84^{b}	127.5^{ab}	167.5^{bc}
T_3	13.78^{a}	92.34^{a}	168.4^{a}	218.1^{a}
T_4	11.71^{a}	64.70^{b}	159.1^{a}	215.3^{a}
T_5	13.44^{a}	86.92^{a}	172.4^{a}	203.3^{ab}
T_6	4.64^{bc}	32.16^{d}	79.5^{bc}	117.9^{d}
T_7	3.36^{c}	13.13^{e}	26.2^{c}	66.5^{e}
T_8	5.37^{bc}	35.64^{cd}	97.4^{b}	133.2^{cd}
F-probability	**	**	**	**
SEm (±)	1.465	8.25	25.05	17.84
LSD(α=0.05)	3.141	17.70	53.72	38.26
CV,%	21.8	18.8	25.6	13.6
Grand mean	8.23	53.8	119.6	160.3

Note: CV, coefficient of variation; SEm, standard error of mean; LSD, least significant difference; * significant at 0.05 level of significance; ** significant at 0.01 level of significance; ns, non-significance. Values with the same letter(s) with in a column are not significantly different at 0.05 level of significance based on Duncan's multiple range test (DMRT).

Table 2. Effects of integrated nutrients management on number of leaves and branches per plant of watermelon at Rapti riverbed, Dang, Nepal.

Treatments	Number of leaves per plant				Number of branches per plant			
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS
T_1	6.56^{b}	20.07^{bcd}	45.15^{abc}	56.77^{bc}	0	3.24^{cd}	4.44^{b}	5.50^{bcd}
T_2	6.33^{b}	24.05^{bc}	39.84^{bcd}	51.97^{cd}	0	3.28^{cd}	4.56^{b}	5.17^{cde}
T_3	11.28^{a}	36.10^{a}	60.75^{a}	76.58^{a}	0	5.17^{a}	5.83^{a}	6.96^{a}
T_4	9.08^{a}	29.47^{ab}	55.77^{ab}	75.73^{a}	0	4.11^{bc}	5.83^{a}	6.67^{ab}
T_5	9.56^{a}	34.90^{a}	52.53^{ab}	70.99^{ab}	0	4.56^{ab}	5.72^{a}	6.33^{abc}
T_6	5.78^{b}	14.59^{cde}	24.79^{de}	33.47^{de}	0	2.22^{ef}	3.44^{bc}	4.07^{ef}
T_7	2.94^{c}	9.79^{e}	15.64^{e}	21.02^{e}	0	1.39^{f}	2.58^{c}	3.08^{f}
T_8	5.28^{bc}	12.49^{de}	29.06^{cde}	41.92^{cd}	0	2.56^{de}	3.60^{bc}	4.37^{de}
F-probability	**	**	**	**	0	**	**	**
SEm (±)	1.137	4.43	7.21	8.33	0	0.3960	0.508	0.555
LSD(α=0.05)	2.482	9.49	15.47	17.86	0	0.8493	1.090	1.190
CV,%	19.6	23.9	21.8	19.0	0	14.6	13.8	12.9
Grand mean	7.10	22.7	40.4	53.6	0	3.314	4.50	5.27

Note: CV, coefficient of variation; SEm, standard error of mean; LSD, least significant difference; * significant at 0.05 level of significance; ** significant at 0.01 level of significance; ns, non-significance. Values with the same letter(s) within a column are not significantly different at 0.05 level of significance based on Duncan's multiple range test (DMRT).

Table 3. Effects of integrated nutrients management on fruit and vine tissues contents of watermelon at Rapti riverbed, Dang, Nepal.

Treatments	Fruit tissue analysis			Vine tissue analysis		
	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T_1	1.60^{ab}	1.85	5.83^{b}	2.53bc	0.04	2.60
T_2	1.41^{ab}	1.38	6.96^{a}	2.22c	0.26	3.35
T_3	1.96^{a}	1.81	7.17^{a}	4.20a	0.34	3.01
T_4	1.85^{a}	1.33	5.51^{b}	3.80a	0.44	2.87
T_5	1.75^{a}	1.46	5.84^{b}	3.97a	0.28	3.07
T_6	1.07^{bc}	1.12	5.00^{b}	4.16a	0.29	2.53
T_7	0.76^{c}	1.18	4.01^{c}	2.12c	0.26	2.78
T_8	1.47^{ab}	1.40	5.97^{b}	3.57ab	0.40	2.76
F-probability	*	Ns	**	*	Ns	Ns
SEm (±)	0.254	0.374	0.415	0.556	0.083	0.258
LSD(α=0.05)	0.545	0.802	0.889	1.193	0.178	0.552
CV,%	21.0	31.8	8.8	20.5	35.0	11.0
Grand mean	1.485	1.441	5.79	3.32	0.290	2.873

Note: CV, coefficient of variation; SEm, standard error of mean; LSD, least significant difference; * significant at 0.05 level of significance; ** significant at 0.01 level of significance; ns, non-significance. Values with the same letter(s) within a column are not significantly different at 0.05 level of significance based on Duncan's multiple range test (DMRT).

from neem seed cake powder+ chemical fertilizer application followed by application of poultry manure+ chemical fertilizer and cattle manure + chemical fertilizer (Tables 3).

It might be due to neem seed cake powder quick acting properties, faster decomposition and quick release of nutrients for crop uptake due to its low C: N ratio. The neem seed cake has an organic matter content, which has the ability to improve the physical characteristics of the soil, leading to improved water and nutrient holding capacities of the soil that probably aided crop growth and yield. Neem seed cake is quick acting, provides slow and steady nourishment and improves yield and quality of crops (Gaur *et al.*, 1992). The study conducted about integrated nutrient management practices of cucumber recorded similar pattern of result i.e. highest yield of 21.39t ha^{-1} with neem cake at 5 tha^{-1} which was 17% superior to the recommended dose of chemical fertilizers, which was also comparatively higher than farm yard manure (FYM), vermicompost and poultry manure (Sharma *et al.*, 2012), which support the present finding of this research. The yield obtained from poultry manure+ chemical fertilizer was higher than other treatments after neem seed cake powder+ chemical fertilizer application. Poultry manure is also a valuable source of plant nutrients for crops. Having low C:N ratio, it also encourage rapid mineralization, and possess both readily available and slow release nitrogen. Maduagwuna *et al.* (2021) observed that the application of 8 tha^{-1} of poultry manure resulted in significantly higher number of fruits and increased yield of chili peppers which is in line with this study.

Table 5. Effects of integrated nutrients management on soil nutrients status of watermelon research field at Rapti riverbed, Dang, Nepal.

Treatments	Soil nutrients analysis (0-20 cm)			
	Organic matter (%)	Total nitrogen (%)	Available P (kgha^{-1})	Available K (kgha^{-1})
T_1	0.42 (0.96)^{ab}	0.06 (0.75)	73.67 (8.37)	194.40 (13.73)
T_2	0.57 (1.03)^{a}	0.26 (0.87)	150.19 (11.74)	146.00 (12.02)
T_3	0.72 (1.10)^{a}	0.08 (0.76)	99.91 (9.72)	146.80 (12.09)
T_4	0.41 (0.96)^{ab}	0.13 (0.79)	103.17 (9.93)	167.00 (12.74)
T_5	0.68 (1.08)^{a}	0.12 (0.78)	125.02 (10.92)	195.03 (13.54)
T_6	0.22 (0.85)^{b}	0.12 (0.79)	56.94 (7.22)	106.03 (10.32)
T_7	0.19 (0.83)^{b}	0.08 (0.76)	54.81 (7.37)	85.07 (9.24)
T_8	0.42 (0.95)^{ab}	0.13 (0.79)	137.25 (11.72)	152.07 (12.20)
F-probability	*	Ns	Ns	Ns
SEm (±)	0.0629	0.0518	2.396	2.015
LSD(α=0.05)	0.1349	0.1111	5.138	4.321
C.V,%	7.9	8.1	30.5	20.6
Grand mean	0.970	0.787	9.62	11.98

Note: CV, coefficient of variation; SEm, standard error of mean; LSD, least significant difference; * significant at 0.05 level of significance; ** significant at 0.01 level of significance; ns, non-significance. Numbers inside the bracket shows square root transformed data, Values with the same letter(s) within a column are not significantly different at 0.05 level of significance based on Duncan's multiple range test (DMRT).

Table 5. Effects of integrated nutrients management on soil nutrients of watermelon research field.

Treatments	Soil nutrients analysis (20-50 cm)			
	Organic matter (%)	Total nitrogen (%)	Available P (kgha^{-1})	Available K (kgha^{-1})
T_1	0.35 (0.92)	0.10 (0.77)	46.23 (6.83)	104.70 (10.25)
T_2	0.46 (0.98)	0.10 (0.77)	155.60 (12.26)	151.20 (12.31)
T_3	0.51 (0.99)	0.13 (0.79)	94.80 (9.63)	130.00 (11.42)
T_4	0.26 (0.87)	0.10 (0.77)	109.51(10.11)	104.23 (10.09)
T_5	0.56 (1.03)	0.11 (0.78)	96.52 (9.63)	148.87 (11.90)
T_6	0.46 (0.98)	0.07 (0.75)	45.38 (6.74)	113.60 (10.68)
T_7	0.47 (0.98)	0.22 (0.85)	31.65 (5.35)	128.97 (11.37)
T_8	0.34 (0.91)	0.18 (0.82)	177.85 (13.31)	107.96 (10.30)
F-probability	Ns	Ns	Ns	Ns
SEm (±)	0.0765	0.02776	1.876	1.323
LSD(α=0.05)	0.1642	0.05954	4.024	2.838
CV,%	9.8	4.3	24.9	14.7
Grand mean	0.958	0.7893	9.23	11.04

Note: CV, coefficient of variation; SEm, standard error of mean; LSD, least significant difference; * significant at 0.05 level of significance; ** significant at 0.01 level of significance; ns, non-significance. Numbers inside the bracket show square root transformed data, Values with the same letter(s) within a column are not significantly different at 0.05 level of significance based on Duncan's multiple range test (DMRT).

Effects of different sources of organic manures and integrated nutrients management on soil parameters of watermelon field

Before conducting research, the initial pH of riverbed soil or experimental area was found to be slightly alkaline i.e. it was 7.96 at soil depth 0-20 cm and 8.01 at depth 20-50 cm. Pati *et al.* (2016) observed approximate similar pH range i.e. 6.7-7.96 along 6 sampling sites of Mahanadi River soil at Cuttack, Odisha, Yu *et al.* (2014a) also reported that the mean pH of the tidal river network region soils which varied from 8.7 to 9.2 was strongly alkaline. It was also found that the soil characteristics in riverbank region have low nutrients and low organic matter (Yu *et al.*, 2014b). The high pH in riverbed soil may be due to low organic matter content of soil as well as the field/ riverbank was not cultivated before. After research/ harvesting of crops, soil pH was not significantly different among the treatments at both the depth of sample taken but the highest (7.47) pH was obtained from control plot and lowest from neem seed cake + chemical fertilizer (6.85), at the depth of 0-20 cm. The results may not be significant within one cropping season. Similar findings that the soil fertility parameters were not significantly influenced by different treatments, one year after the application, however, there was marked improvement in the overall soil fertility status after one year was reported by (Devadas & Kuriakose, 2005). There was a decrease in soil pH i.e. from slightly alkaline to neutral or/ slightly acidic (Figure 2). This may be due to the increase in organic matter content of soil after application of treatments. During decomposition of organic matter, organic acids may have formed which have slightly decreased soil pH. The decrease in

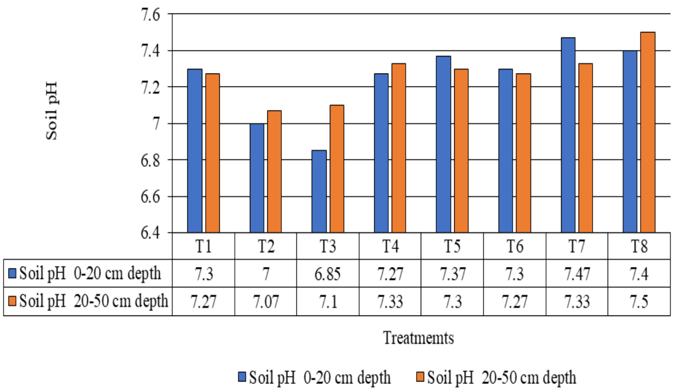

Figure 2. *Effects of integrated nutrients management on soil pH of watermelon research field at Rapti riverbed, Dang, Nepal.*

pH of the soil by about one unit from the initial value which could be related to the decomposition and mineralization of organic matter was also reported by Sheoran *et al.* (2024). Neem seed cake not only provides nutrition to the plant, but also increases the population of earthworms and produces organic acids, which helps in the reduction of soil alkalinity (Korah & Shingte, 1968). The highest (1.10%) amount of OM content in soil was obtained from neem seed cake powder+ chemical fertilizer application which was statistically similar with cattle manure + chemical fertilizer and vermicompost manure + chemical fertilizer. The lowest OM content was obtained from control treatment (0.83%). Regular application of organic manure in amounts sufficient to meet the nutrient requirements of crops not only resulted in increasing the crop yield but also improved the soil fertility and organic matter content (Ramesh *et al.*, 2009) and availability of plant nutrients as compared to chemical fertilizer (Brar *et al.*, 2004). The nitrogen content of soil was not significantly different among the treatments but the highest (0.26%) amount of N content in soil was obtained from vermicompost manure + chemical fertilizer. The highest (150.19) amount of phosphorus content in soil was obtained from vermicompost manure + chemical fertilizer and lowest from control plot (54.81) which was not significantly different among the treatments. The potassium content was also not significantly different among the treatments but the highest (195.03) amount of potassium content in soil was obtained from cattle manure + chemical fertilizer and lowest from control plot (85.07) (Tables 4 and 5). Organic manure such as neem seed cake, vermicompost, animal manure and others, has a long term effect of building the organic matter content of soil which helps in improving the soil physical properties and hence increase the nutrient status of impoverished soils (Eifediyi *et al.*, 2015).

Economic analysis of watermelon cultivation

Regarding economic analysis of watermelon cultivation, poultry manure + chemical fertilizer treatments resulted in the highest B:C ratio (7.44) than other treatments which were statistically similar with cattle manure + chemical fertilizer (6.96), neem seed cake powder+ chemical fertilizer (6.47) and full dose of N, P_2O_5, K_2O from chemical fertilizer (6.43). Moreover, fruit weight per plant and yield (tha^{-1}) of neem seed cake powder+ chemical fertilizer was also significantly different from other treatments (Figure 3). The findings of our study are supported by Aguyoh *et al.* (2010) who reported that integrated nutrient application improved the economics of watermelon cultivation.

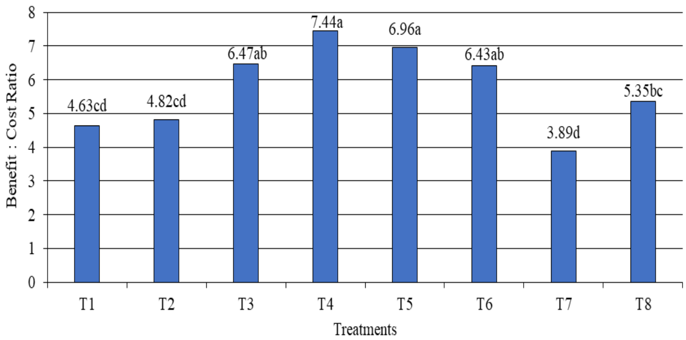

Figure 3. *Economic analysis of watermelon cultivation per hectare of land at Rapti riverbed, Dang, Nepal.*

Conclusion

The result of the experiment clearly shows that the integration of neem seed cake power at the rate of 55 N $kgha^{-1}$ and N, P_2O_5, K_20 at rate of 55: 40: 40 $kgha^{-1}$ significantly increases growth parameters such as vine length (cm), number of branches, number of leaves and yield parameters such as number of fruit per plant, weight of fruits per plant. Similarly, the soil physio-chemical properties like soil pH, soil organic matter content, total nitrogen, available phosphorus and potassium content were also improved. High B:C ratio was obtained from poultry manure application, due to its low price and easy availability, watermelon cultivation using poultry manure could be considered the next better option for Nepalese farmers. Though, B:C ratio was highest in poultry manure+ chemical fertilizer followed by cattle manure+ chemical fertilizer and neem seed cake powder + chemical fertilizer, if we can prepare neem seed cake powder locally by crushing the neem seed, similarly as oil cake, B:C ratio from neem seed cake application can be maximized along with high production. Hence, the use of neem seed cake powder integration with inorganic fertilizers is very best to produce watermelon in riverbed areas as it helps to improve soil properties and yield.

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DECLARATIONS

Author contribution statement

Conceptualization, P.S., C.P.S. and D.D.; Methodology, P.S., C.P.S., D.D. and B.D.; Software and validation, P.S. and D.D., Formal analysis, P.S; Investigation, P.S; Data curation, P.S; Writing Original draft preparation, P.S; review and editing, P.S, C.P.S, D.D and B.D; Supervision, C.P.S, D.D and B.D.; Project administration: P.S..; Funding acquisition: P.S. All the authors have read and approved the final manuscript.

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