Integrated nutrient and weed management on nutrient content, uptake and soilfertility ofbuckwheat (*Fagopyrum esculentum* L.) production in Eastern Sub-Himalayan Plain of India

ABSTRACT

A field experiment was conducted during winter (*rabi*) season of 2019-20 at Uttar Banga Krishi Viswavidyalaya, West Bengalto study the effect of integrated nutrient and weed management on nutrient content, uptake and soil fertility ofbuckwheat production.Results indicated that nutrient content, uptake and soil fertility status were significantly influenced due to effect of integrated nutrient and weed management.Significantly highest nitrogen, phosphorus and potassium uptake recorded with 50% RDF + Vermicompost @ 1.5 t ha^{-1} × Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS which was at par with100% RDF × Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS and 50% RDF + Vermicompost @ 1.5 t ha^{-1} × Oxyfluorfen 23.5 EC @ 0.2 kg ha^{-1} at 2 DAS + One Hoeing at 40 DAS. The lowest was observed with control. The highest available soil nitrogen was observed with Vermicompost @ 3.0 t ha^{-1}× Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS (198.7 kg ha^{-1}).The lowest available soil nitrogen was recorded with control (176.0 kg ha^{-1}).The available soil organic carbon content, soil phosphorus and exchangeable potassium observed non-significant in differences. Higher B:C ratio was observed with 100 % RDF combined with all the weed management treatment (3.87-3.52) followed by 50% RDF + Vermicompost @ 1.5 t ha^{-1} (2.43-2.62) and Vermicompost @ 3 t ha^{-1} (1.41-1.64) in combination with all the weed management treatment except control (1.84).

Keywords**:** Buckwheat, Nutrient content and uptake, Soil fertility

INTRODUCTION

"Common buckwheat *(Fagopyrum esculentum* Moench) has been a crop of secondaryimportance in many countries and presently cultivated throughout the world" (Campbell, 1997) "However, the crop is gaining potential as a future crop in terms of adaptation to climatic variables"(Yadav et al., 2017 and Baniya,2001). "The crop is known as a pseudo-cereal as its grains belong to cereals because of their similar use and chemical composition. Grains are consumed as staple food by tribal communities in North-Eastern hilly tract of India. The crop is cultivated for dual uses, leafy vegetable as well as grains in some parts of India" (Paul and Nandi, 2020).

Nutrient management is a very important aspect for proper growth and development of crops. Application of chemical fertilizers may increase production but at the same time it haslead to environmental pollution. Heavy and injudicious use of chemical fertilizers deteriorates soil health and organic carbon, reducing the factor productivity. However, these may be avoided by the application of organic manures. "Organic manures applied in a sequence have been shown to improve the use efficiency of inorganic fertilizers"(Jeyabal and Kuppuswamy, 2001)."Application of organic manures along with inorganic fertilizers leads to increased productivity and also sustains soil health for a long run. The combined use of organic manures and inorganic fertilizers provides a sustainable soil nutrient balance, enhances soil aggregation, and increases moisture retention capacity and soil fertility"(Tadesse *et al*., 2013)."Organic manure on the other side, provides a good substrate for the growth of microorganism and maintain a favourable nutrient supply environment to the crop. Use of organic and inorganic sources of nutrients form is a judicious application of nutrients in order to maintain environmental health. Efficiency of nutrient supply and economics of crops under organic and inorganic sources of nutrient management has immense importance for higher profitability. Among various organic manures, vermicompost are commonly used organic manures in plant nutrient management. Manure application has also been reported to increase the N and exchangeable cation levels in the soil" (Boateng *et al*., 2006). "Studies indicated that organic manure increases macropore space, resulting in improved air-water relationship. The application of vermicompost had favourable effects on soil pH, microbial population and soil enzyme activities" (Maneswarippa*et al.*, 1999). "Integrated use of vermicompost and recommended dose of NPK significantly increased organic carbon content of soil" (Kannan, *et al*., 2013). Decomposition of organic matter not only releases plant nutrients but also the organic acid produced during this process releases native soil nutrients in soil that become available to plants (Shilpashree *et al*., 2012).

MATERIALS AND METHODS

A field experiment was carried out during winter (*rabi*) seasons of 2019-20 at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal to study the effectof integrated nutrient and weed management on nutrient content, uptake and fertility status of soil after harvest ofbuckwheat (*Fagopyrum esculentum* L.).The farm is situated at $26^0$19'86" N latitude and $89^0$23'53" E longitude at an elevation of 43 meter above mean sea level. Thephysico-chemical properties of experimental soil was sandy loam in texture with pH 5.49, medium in organic carbon (0.68%), medium in available nitrogen (176.5 kg/ha), medium in available phosphorus (13.6 kg/ha) and low in available potassium (69.4 kg/ha). The experiment was laid out in randomized block design having ten treatment combinations having 3 nutrient management and 3 weed management treatment and one additional control (weedy) [*viz*:T_1: control T_2: 100% RDF × Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS, T_3: 100% RDF × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS, T_4: 100% RDF × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS + One hoeing at 40 DAS, T_5: 50% RDF + Vermicompost @ 1.5 t ha^{-1} × Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS, T_6: 50% RDF + Vermicompost @ 1.5 t ha^{-1} × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS, T_7: 50% RDF + Vermicompost @ 1.5 t ha^{-1} × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS + One hoeing at 40 DAS, T_8: Vermicompost @ 3.0 t ha^{-1} × Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS, T_9: Vermicompost @ 3.0 t ha^{-1} × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS and T_{10}: Vermicompost @ 3.0 t ha^{-1} × Oxyfluorfen 23.5% EC @ 0.2 kg ha^{-1} at 2 DAS + One hoeing at 40 DAS] replicated thrice. The soil was prepared by tractor drawn cultivator followed by rotavator. The whole experimental field was divided into thirty small plots having the size 4 m × 4 m following the layout plan. Vermicompost and fertilizers were broadcasted on the respective plots prior to layout preparation. First 2/3 of N, full dose of P and K were applied as basal and remaining 1/3 N was top dressed at 30 DAS. Fertilizers were applied through urea, single super phosphate and muriate of potash. Rice straw mulch was applied one day after sowing, as per treatment taken under study. Pre-emergence application of Oxyfluorfen 23.5% EC was done at one day after sowing and post-emergence application done at 40 days after sowing (DAS). The buckwheat variety 'Himpriya' was taken in the present study. The seed was sown on 04^{th} December, 2020 maintaining 30 cm × 10 cm plant geometry. Two irrigation were given during the crop growth period. The crop was matured in last week of February and harvested on 28^{th} February, 2021.

Harvesting was done manually when all leaves and inflorescences turned yellow colour and grains moisture content around 20%. The grain samples collected at harvest from each experimental unit were oven dried at 65°C to a constant weight and grounded in laboratory mill. These samples were subjected to chemical analysis for determination of nutrient concentrations (N, P and K). Samples were digested in di-acid mixture (HNO_3 $HClO_4$, 10:1 by volume) and the digest was analysed for P by vanado molybdate yellow colour method and K by flame photometer.And nitrogen was analysed with nessler's reagent colorimetric method (Snell and Snell, 1949). And based on content uptake was calculated with the formula:-

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content in green cobs /fodder} \times \text{yield of green cobs /fodder}}{100}$$

Soil samples collected after harvest were analysed for organic carbon, available N (Subbiah and Asija 1956) and available P (Olsen *et al*. 1954), available K (Jackson 1973).

RESULTS AND DISCUSSION

Nutrient content

Combined management of nutrient and weed with different levels of recommended dose of fertilizer showed a significant difference in nutrient content of buckwheat at harvest(Table 1). Among the different dose and weed management practiceshighly**s**ignificantly differences were observed for nitrogen and potassium content recorded with 100% RDF ×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS.Nitrogen content was found at par with100% RDF ×Oxyfluorfen 23.5 EC @ 0.2 kg ha^{-1} at 2 DAS + One Hoeing at 40 DAS, 50% RDF + Vermicompost @ 1.5 t ha^{-1}×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS and 50% RDF + Vermicompost @ 1.5 t ha^{-1}×Oxyfluorfen 23.5 EC @ 0.2 kg ha^{-1} at 2 DAS + One Hoeing at 40 DAS. Lowest value was observed with control. The data showed that concentration of phosphorus was found non-significant. However,slightly higher phosphorus content recorded with 100% RDF ×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS.

The nutrient content of N, P and K by grain was increased significantly in treatment receiving 50% RDF + vermicompost or vermicompost alone over other treatments. The positive influence of integrated use of inorganic nutrients along with vermicompost in N, P and K status of grain seems to be due to their increased availability from soil. Moreover, higher photosynthetic activity in plant as evident from increase in biomass accumulation at successive growth stages and plant height reveals higher availability of metabolites from shoot to root. This might have promoted growth of roots as well as their functional activity resulting in higher extraction of nutrients from soil environment to aerial parts. The results of the present investigation supported the findings of Joshi, *et al.* **(**2018).Pre-emergence application of herbicides combined with one hoeing significantly reduced the weed dry matter (Priya *et al.* 2017, Janaki *et al*. 2013) and increased the uptake of nutrient. Application of mulch also suppressed the growth of weeds and added increased nutrient content(Asif *et al.* 2020).

Plant nutrient uptake

Buckwheat's nutrient uptake at harvest varies significantly when weeds and nutrients are managed together at varying levels of the prescribed fertilizer dosage (Table 2).Significantly highest nitrogen, phosphorus and potassium uptake were recorded with 50% RDF + Vermicompost @ 1.5 t ha^{-1}×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS which was at par with100% RDF ×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS and 50% RDF + Vermicompost @ 1.5 t ha^{-1}×Oxyfluorfen 23.5 EC @ 0.2 kg ha^{-1} at 2 DAS + One Hoeing at 40 DAS. The lowest was noted when using control.

Table 1. Effects of integrated nutrient and weed management on nutrient content in grain of buckwheat

Treatment	N content (%)	P content (%)	K content (%)
T_1	1.95	0.38	0.64
T_2	2.17	0.42	0.74
T_3	2.11	0.40	0.73
T_4	2.16	0.39	0.72
T_5	2.15	0.41	0.73
T_6	2.11	0.39	0.72
T_7	2.13	0.40	0.71
T_8	2.11	0.40	0.72
T_9	2.09	0.38	0.69
T_{10}	2.08	0.40	0.71
Sem±	0.02	0.01	0.02
LSD (p=05)	0.05	NS	0.05

The uptake of N, P and K by grain was increased significantly in treatment receiving 50% RDF + vermicompost or vermicompost alone over other treatments. The nutrient uptake is a function of yield and nutrient concentration in plant. Thus, significant improvement in uptake of N, P and K might be attributed to their concentration in grain and associated with higher grain yield. This might also be attributed to better availability of nutrients in the soil under these treatments. The results of present investigation are in close agreements with the findings of Dadarwal,(2008)and Joshi, *et al.***(**2018).Pre-emergence application of herbicides combined with one hoeing significantly reduced the weed dry matter (Priya *et al.* 2017, and Janaki *et al*. 2013) and increased the uptake of nutrient. Application of mulch also suppressed the growth of weeds and added increased nutrient uptake.

Table 2. Effects of integrated nutrient and weed management on nutrient uptakein grain of buckwheat

Treatment	**N uptake (kg ha^{-1})**	**P uptake (kg ha^{-1})**	**Kuptake (kg ha^{-1})**
T_1	14.0	2.75	4.59
T_2	34.2	6.68	11.71
T_3	28.4	5.44	9.89
T_4	32.6	5.88	10.80
T_5	35.4	6.70	12.05
T_6	29.7	5.54	10.15
T_7	33.2	6.20	11.11
T_8	32.1	6.04	11.00
T_9	27.4	5.03	9.04
T_{10}	30.5	5.90	10.41
Sem±	0.92	0.22	0.46
LSD(p=05)	2.75	0.64	1.38

Soil fertility status

Application of different levels of RDF and weed management practices did not make any significant contribution in soil organic carbon, available phosphorus and potassium. However, all were found slightly higher with Vermicompost @ 3.0 t ha^{-1}in combination with all the weed management treatment followed by 50% RDF + Vermicompost @ 1.5 t ha^{-1} in combination with all the weed management treatment.The significantly higher available soil nitrogen observed with Vermicompost @ 3.0 t ha^{-1}in combination with all the weed management treatment (189.5-198.7kg ha^{-1}) followed by 50% RDF + Vermicompost @ 1.5 t ha^{-1} in combination with all the weed management treatment. The highest was observed with Vermicompost @ 3.0 t ha^{-1}×Rice straw mulch @ 5 t ha^{-1} applied at 2 DAS (198.7kg ha^{-1}).The lowest available soil nitrogen was recorded with control (176.0 kg ha^{-1}) (Table 3).

The status of available organic carbon, P and K in the soil was statistically similar, but N content was significantly improved (Table 3). The significant build-up of available N, P and K status under integrated nutrient and weed management could be attributed to adequate supply of N, P and K to meet the crop requirement. The results of present investigation supported the findings of Das *et al.* (2008),Dadarwal, (2008) and Joshi, *et al.* (2018).Application of mulch increased soil organic carbon, ranging from 3.19 to 5.45 mg kg^{-1} of soil and maximum soil organic carbon (5.45 mg per kg of soil), which was observed under the application of wheat straw mulch and also reported that mulching treatments added the nutrients in soil(Pervaiz *et al*. 2009 and Asif *et al.* 2020).

Table 3. Effects of integrated nutrient and weed management on soil fertility of buckwheat

Treatment	Soil organic C (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Exchangeable K_2O (kg ha^{-1})
T_1	0.68	176.0	14.5	71.5
T_2	0.73	179.8	14.5	74.7
T_3	0.69	176.9	13.7	73.8
T_4	0.69	173.9	14.3	73.7
T_5	0.74	189.1	15.7	77.9
T_6	0.73	181.2	14.3	74.4
T_7	0.69	175.7	14.3	77.2
T_8	0.77	198.7	16.6	84.4
T_9	0.74	186.6	14.1	81.9
T_{10}	0.72	189.5	15.2	78.0
Sem±	0.02	4.87	1.06	3.36
LSD (p=05)	NS	14.60	NS	NS

CONCLUSION

On the basis of experimental findings, it could be concluded that integrated treatments, 50% RDF with vermicompost @ 1.5 t ha^{-1}and Vermicompost @ 3 t ha^{-1} combined with Rice straw mulch @ 5 t ha^{-1} at 2 DAS / Oxyfluorfen 23.5 EC @ 0.2 kg ha^{-1} at 2 DAS + One Hoeing at 40 DAS showed better results in terms of nutrient content, uptake and soil fertility status. However, these findings are based on one year's experimental data and hence, need further confirmation.

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