The Pharma Innovation Journal 2021; 10(11): 1168-1170

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 1168-1170

www.thepharmajournal.com
Received: 04-09-2021
Accepted: 16-10-2021

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Effect of NPK and different level of micronutrients on growth, herbage yield and leaf quality of Red Amaranths (*Amaranthus cruentus*) cv. Lal Saag

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Abstract
Experiment titled Effect of NPK and different level of micronutrients on growth, herbage yield and leaf quality of Red Amaranths (*Amaranthus cruentus*) cv. Lal Saag during Rabi Season 2020-2021 on research farm of the Department Horticulture, AKS University, Satna (MP). The experiment was placed in a randomized block design with three repeated 12 treatments *viz.*, T_0: Without Fertilizer (Control), T_1: 50 kg N/h + 25 kg P/h + 20 kg K/h (RDF), T_2: Zinc @ 5kg/h + Boron @2kg/h, T_3: 100% (RDF) + Zinc @ 5kg/h, T_4: 100% (RDF) + Boron @2kg/h, T_5: 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h, T_6: 80% (RDF) + Zinc @ 5kg/h, T_7: 80% (RDF) + Boron @2kg/h, T_8: 80% (RDF) + Zinc @ 5kg/h + Boron @2kg/h, T_9: 60% (RDF) + Zinc @ 5kg/h, T_{10}: 60% (RDF) + Boron @2kg/h, T_{11}: 60% (RDF) + Zinc @ 5kg/h + Boron @2kg/h. The results reveal the treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h was found superior in growth yield with quality corrector. In this investigation the treatment T_2 - VC@ 2.5t/h + Spent Rice Husk Compost @ 2.5t/h + Biochar 1t/h + Bamboo Leaf Compost 0.1 t/h was found suitable for cultivation in winter season for better green foliage yield (8.03t/ha) for Red Amaranths under satna condition.

Keywords: Red amaranths, boron, zinc, NPK

Introduction
Amaranth grows upright at first, reaching a height of 10–150 cm (rarely up to 3 m), but is usually lowered to the second after flowering (due to the weight of the leaves and seeds). Not supported by plants. Its native range is unclear due to widespread cultivation, but it covers most of Europe. Plants native to East Asia are included under C. album, but are often separated from European specimens. It has been widely introduced elsewhere, e.g. Africa, Australia, North America and Oceania, and now occurs almost everywhere in nitrogen-rich soils, especially on wastelands. The species is cultivated as a cereal or vegetable crop (e.g. in lieu of spinach) as well as animal feed in Asia and Africa, while in Europe and North America, it is commonly used as a weed in places such as potatoes, wheat farm. Application of Boron, Zinc and recommended dose of NPK have essential roles in the development of crop yield and product quality. Farmers have increased the application of nitrogen fertilizers on their land from year to year without considering nutrient rates and the response of different species to their forms. Adequate supply of fertilizers can promote plant growth and increase crop production, but excessive and improper use of chemical fertilizers leads to the accumulation of compounds in food products that have harmful effects on human health, environmental pollution and cause economic loss.

Materials and Methods
Experiment titled Effect of NPK and different level of micronutrients on growth, herbage yield and leaf quality of Red Amaranths (*Amaranthus cruentus*) cv. Lal Saag during Rabi Season 2020-2021 on research farm of the Department Horticulture, AKS University, Satna (MP). The experiment was placed in a randomized block design with three repeated 12 treatments *viz.*, T_0: Without Fertilizer (Control), T_1: 50 kg N/h + 25 kg P/h + 20 kg K/h (RDF), T_2: Zinc @ 5kg/h + Boron @2kg/h, T_3: 100% (RDF) + Zinc @ 5kg/h, T_4: 100% (RDF) + Boron @2kg/h, T_5: 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h, T_6: 80% (RDF) + Zinc @ 5kg/h, T_7: 80% (RDF) + Boron @2kg/h, T_8: 80% (RDF) + Zinc @ 5kg/h + Boron @2kg/h, T_9: 60% (RDF) + Zinc @ 5kg/h, T_{10}: 60% (RDF) + Boron @2kg/h, T_{11}: 60% (RDF) + Zinc @ 5kg/h + Boron@2kg/h.

The main field was brought to fine tilth by repeated ploughings followed by harrowing. After that rocks and debris were removed from the field soil. Finally it was levelled and replications were demarcated using bund former. Each replication was further divided into plots and a total of 36 plots were laid out. Inorganic and Organic source to be incorporated as per treatments and thoroughly mixed into the soil before sowing.

Red Amaranths seeds were sown on 25 November 2020, germination started and was completed on 2 December, recording observations were made 15 days after sowing and subsequent readings were recorded after every 15 days interval. The Red Amaranths crop was harvested 29th December - 2020. All facilities required for farming including labor were provided in the department. Well rotten FYM @ 250 q ha-1 was applied at the time of field preparation. The field was fertilized with 60 kg ha-1 phosphorus and 50 kg ha-1 potash to supply nitrogen at the rate of 120 kg ha-1. Add urea in three equal amounts. Apply first dose of urea at the time of sowing with single superphosphate and full dose of muriate of potash. Apply light irrigation after sowing the seeds. The observations were made at 15, 30 and at harvest. The data recorded during the investigation were subjected to statistical analysis according to the method of analysis of variance (Panse and Sukhatme, 1967). Significance and non-significance of treatment effect were assessed with the help of the 'F' variance ratio test. The calculated 'F' value (variance ratio) was compared with the table value of F' at the 5% significance level. If the calculated value is greater than the table value, the effect was considered significant. Significant differences between means were tested against significant differences at the 5% significance level.

Result

Data mentioned in table 1 clearly revealed that the optimum levels of nutrients were found to significantly improve plant height at all the growth stages. The significantly higher plant height of Red Amaranths was recorded under T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h with the respective values of 12.67cm, 26.36 cm and 38.11 cm at growth stage of 15, 30 and at harvest, respectively. The optimum levels of nutrients were found to significantly improve branches/plant. The significantly higher number of branches/plant of Red Amaranths was recorded under T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h with the respective values of 2.33, 5.46 and8.74 at growth stage of 15, 30 and at harvest, respectively. These results closely match with the findings of Pandey (2005) [9], Pandey and Singh (2010) [10], Manikandan *et al.* (2015) [6], Mondal *et al.* (2015) [7], Toungos *et al.* (2018) [15] and Bisikwa *et al.* (2020) [2]. The optimum levels of nutrients were found to significantly improve number of leaves per plant. The significantly maximum number of leaves per plant of Red Amaranths was recorded under T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h with the respective values of 23.45 days proved significantly superior to rest of the treatments. The optimum levels of nutrients were found to significantly improve leaf length (cm). The significantly maximum leaf length (cm) of Red Amaranths was recorded under T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h with the respective values of 14.78 cm proved significantly superior to rest of the treatments. Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum Leaf width (9.83 cm) followed by 9.50 cm with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum Leaf width (4.21cm) was recorded with T_0 - Without Fertilizer (Control). The results of present study are almost matched with the findings of Gamel *et al.* (2004) [4], Rana *et al.* (2006) [12], Shukla *et al.* (2010) [14] and Dehariya *et al.* (2019) [3]. Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum Leaf area (24.9 cm^2) followed by 24.5 cm^2 with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum Leaf area (18.6 cm^2) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum stem diameter (2.56 cm) followed by 2.51 cm with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum stem diameter (1.08 cm) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum herbage yield per plant (261.43 g) followed by 248.01 g with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum herbage yield per plant (73.62g) was recorded with T_0 - Without Fertilizer (Control). Results related to fresh weight (g) of Red Amaranths found to be close agreement with that of Pospisil *et al.* (2006) [11], Alvarez-Jubete *et al.* (2010) [1], Ohshiro *et al.* (2016) [8], Kahu *et al.* (2019) [5] and Samkeliso *et al.* (2020) [13]. Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum herbage yield per plot (6.274 kg) followed by 5.952 kg with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum herbage yield per plot (1.766 kg) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum herbage yield (29.86 t/ha) followed by (27.51 t/ha) with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum herbage yield (5.28t/ha) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum TSS (3.47 ºBrix) followed by (3.30 ºBrix) with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum TSS (2.07 ºBrix) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum Ascorbic Acid (28.21 mg/100g) followed by (27.55 mg/100g) with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum Ascorbic Acid (18.37 mg/100g) was recorded with T_0 - Without Fertilizer (Control). Treatment T_5 - 100% (RDF) + Zinc @ 5kg/h + Boron @2kg/h recorded maximum juice (59.42%) in green leaf followed by 58.75% with T_3 - 100% (RDF) + Zinc @ 5kg/h and the minimum juice (41.63%) in green leaf was recorded with T_0 - Without Fertilizer (Control). It is concluded that the treatment T_2 - VC@ 2.5t/h + Spent Rice Husk Compost @ 2.5t/h + Biochar 1t/h + Bamboo Leaf Compost 0.1 t/h was found superior in growth yield with quality corrector. In this investigation the treatment T_2 - VC@ 2.5t/h + Spent Rice Husk Compost @ 2.5t/h + Biochar 1t/h + Bamboo Leaf Compost 0.1 t/h was found suitable for cultivation in winter season for better green foliage yield (8.03t/ha).

Table 1: Effect of NPK and different level of micronutrients on growth, herbage yield and leaf quality of Red Amaranths

Treatments	Plant high (cm)	Branches/plant	Number of leaves /plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Stem diameter (cm)	Herbage yield per plant (g)	Herbage yield per plot (kg)	Herbage yield (t/ha)	TSS (° Brix)	Ascorbic acid (mg/100g)	Juice (%) in green leaf
T_0	18.32	4.67	8.62	6.82	4.21	18.6	1.08	73.62	1.766	5.28	2.07	18.37	41.63
T_1	34.57	7.61	20.81	13.89	8.81	24.0	2.45	207.92	4.990	24.04	3.02	25.64	56.40
T_2	22.75	5.28	10.19	8.16	7.36	20.8	1.13	120.54	2.892	9.61	2.31	21.94	50.33
T_3	36.74	8.39	21.72	14.53	9.50	24.5	2.51	248.01	5.952	27.51	3.30	27.55	58.75
T_4	35.06	7.88	21.55	14.36	9.28	24.3	2.48	213.68	5.128	26.43	3.19	25.87	57.18
T_5	38.11	8.74	23.45	14.78	9.83	24.9	2.56	261.43	6.274	29.86	3.47	28.21	59.42
T_6	29.48	7.20	17.43	11.94	8.47	23.4	2.32	187.57	4.501	21.77	2.94	24.56	55.43
T_7	28.52	6.97	16.94	11.60	8.22	23.0	1.29	171.26	4.110	20.49	2.86	24.03	53.21
T_8	31.80	7.45	17.69	12.27	8.64	23.8	2.37	194.70	4.672	22.25	2.96	24.92	55.57
T_9	25.67	6.56	13.05	10.58	7.75	22.5	1.22	142.33	3.415	15.84	2.55	22.39	51.79
T_{10}	24.41	6.33	12.53	10.35	7.59	22.1	1.18	135.17	3.244	14.35	2.42	22.15	50.54
T_{11}	27.14	6.72	13.27	10.71	7.80	22.9	1.26	159.84	3.836	16.57	2.74	22.48	52.05
S.Ed(±)	0.33	0.07	0.27	0.14	0.67	0.13	0.03	2.95	0.07	0.41	0.02	0.15	0.26
CD at 5%	0.69	0.14	0.55	0.29	1.40	0.27	0.07	6.12	0.15	0.84	0.05	0.31	0.55

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