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Productivity and Quality of Urdbean *(Vigna mungo L.)* Influenced by Fe, Zn and Bio-Fertilizers

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ABSTRACT

A field experiment was conducted on burban during kharif 2021 at Instructional Farm, College of Agriculture, Ummedganj, Kota (Rajasthan). The experiment comprised 10 treatments viz. (Control, 75 % RDF, 100 % RDF, 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation, 75 % RDF + PSB @ 600 g ha-1 seed inoculation, 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1seed inoculation, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 foliar spray at pre-flowering and pod formation stage, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 foliar spray at pre-flowering and pod formation stage + Rhizobium @ 600 g ha-1, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 foliar spray at pre pre-flowering and pod formation stage + PSB @ 600 g ha-1, 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1) was carried out in randomized block design with three replications. The maximum pods plant-1 (34.26), and seeds pod-1(6.93) were recorded with the application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1 seed inoculation in urban over rest of treatments. Application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1seed inoculation produced significantly higher seed yield (1269), straw yield (1512) and biological yield (2782)kg ha-1of urdbeanduring course of experimentation as compared to remaining treatments. Harvest index and test weight did not significantly influence by various treatments of Fe, Zn and Bio-fertilizers.Significantly higher protein content (24.19%) and protein yield (309 kg ha-1) in urban seed were recorded with the application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1 seed inoculation over rest of treatments. The maximum net returns (₹ 81964/- ha-1) and B: C ratio (3.44) were obtained with the application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1seed inoculation.

Keywords: *Bio-fertilizer, Ferrous, protein content, seed yield, urban and zinc*

INTRODUCTION

Pulses are an integral part of the Indian dietary system due to the richest source of protein and other nutrients. Indian population is predominantly vegetarian and the protein requirement for the growth and development of the human being is mostly met with pulses. The availability of pulses per capita per day has proportionately declined from 71 g to 52 g against the minimum requirement of 70 g day-1/capita [1]. Pulses are improving soil fertility by atmospheric nitrogen fixation through Rhizobium culture. In India, pulses have grown an area of 28.34 million ha with a total production of 23.15 million tonnes and productivity of 817 kg ha-1 [2]. Among the pulses, urban [Vigna mungo (L.) Hepper], is an important crop in India. Urdbean is the third most important pulse crop after chickpea and pigeon pea in India.

It is highly nutritious containing 24-26% protein, 1.3% fat and 60% carbohydrates on dry weight basis and it is a rich source of calcium, iron, and vitamins [3].

The major constraints for low yield of urban are lack of micronutrient application and non-adoption of proper agronomic practices. Micronutrients are equally important in plant nutrition as major nutrients. The incidence of micronutrient deficiencies in crops has increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, liming of acid soils, decreased proportions of farmyard manure or other organic sources compared to chemical fertilizers and use of marginal lands for crop production [4]. The optimum supply of micronutrients under balanced conditions is very important for achieving higher productivity of urban. Foliar application of micronutrients has been proven to be an important asset in fertilizer application with a specific aim of increasing nutrient availability at the time of need, especially at the later stage of

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plant growth. Foliar application of nutrients using water soluble fertilizers is one of the possible ways to enhance the productivity of pulses. The foliar fertilization of Zn and Fe at the flowering stage improves the growth and yield of urdbean [5].

Bio-fertilizer plays a vital role in maintaining long-term soil fertility and sustainability [6]. Incorporation of FYM alone or bio-fertilizers improves the available nutrient status of the soil with enhanced soil biological activity which in turn provides a congenial physical condition and improved availability of nutrients in the rhizosphere, resulting in an improvement in the crop growth and providing a better source–sink relationship [7]. Among bio-fertilizers, Rhizobium inoculation is the cheapest, easiest and safest method of supplying nitrogen to legumes through a well-known symbiotic nitrogen fixation process. Inoculation of appropriate strain enhances nodule formation resulting in better nitrogen fixation. Rhizobium species in association with plant roots in urban improved soil fertility by fixing atmospheric nitrogen and producing plant growth substances in the soil. Rhizobium inoculation can increase the grain yield of pulse crops [8].

MATERIAL AND METHODS

A field experiment was conducted on urban during kharif 2021 at Instructional Farm, College of Agriculture, Ummedganj, Kota (Rajasthan). Geographically, is situated at 25.110 North latitudes and 75.500 East longitudes at an altitude of 258 meters above mean sea level (MSL). In Rajasthan, this region falls under the Agro-Climatic Zone-V (Humid South Eastern Plain Zone). This zone possesses typical sub-tropical conditions with a maximum temperature range in summer is 42.2- 43.0 0C and a minimum 12 - 270C. In this zone annual average rainfall is received at 840 mm. The soil of the experimental site was clay loam in texture, slightly saline in reaction, medium in available nitrogen (264 kg ha-1) and phosphorus (21.7 kg ha-1) while high in potassium (388 kg ha-1) and sufficient in DTPA extractable micronutrients with pH (7.61) and EC (0.52 dS m-1). The source of nutrients was applied urea for nitrogen, DAP for phosphorus and mutate of potash for potassium. The full dose of fertilizer 100 % RDF (20:40:30 NPK kg ha-1) was applied as basal dose. Before sowing, seed of urdbean was inoculated with liquid rhizobium culture @ 10 ml kg-1 seed and liquid PSB culture @ 10 ml kg-1 seed as per treatment. Foliar fertilization of zinc sulphate (ZnSO4) and ferrous sulphate (FeSO4) were applied at pre flowering and pod formation stage. Spraying was done with knapsack sprayer and the leaves were wetted thoroughly with a fine mist. For the absorption of solution by urdbean leaves, a sticker was added in the spray solution.

The experiment was laid out in a randomized block design with three replications. The experiment comprised 10 treatments viz. (Control, 75 % RDF, 100 % RDF, 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation, 75 % RDF + PSB @ 600 g ha-1 seed inoculation, 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre-flowering and pod formation stage, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage + Rhizobium @ 600 g ha-1, 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre-flowering and pod formation stage + PSB @ 600 g ha-1, 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1) was carried out in randomized block design with three replications. For recording pre and post-harvest observations, five plants were randomly selected for each plot and tagged with labels for various observations on yield attributes and yield. Data were recorded plot-wise as per standard procedures and statistically analyzed by adopting the appropriate method of standard analysis of variance [9].

Protein content (%)

The seed samples were taken after threshing of the crop, processed, and subjected to analysis for protein contents as affected by different treatments. Total nitrogen was estimated by the micro-Kjeldahl method as per the procedure suggested by [10] and the protein was calculated by the formula given under [11].

Protein content (%) = Kjeldahl nitrogen content (%) x 6.25*

Protein yield was calculated by multiplying the protein content in the seed sample of each treatment with its respective protein yield and expressed in kg ha-1.

MATERIAL AND METHODS

Effect of Fe, Zn, and Biofertilizer on yield attributes and yield

It is evident from data presented in Table 1.0 that the yield attributes and yields of urban significantly influence various treatments of Fe, Zn, and bio fertilizers. The data pertaining to test weight (g) and harvest index (%) did not significantly influence by the application of Fe, Zn and Bio-fertilizers. The perusal of data clearly indicated that the podsplant-1 (34.2) and seed pod-1 (6.9) of urdbeanwere recorded significantlyhigher with application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1seed inoculation over control podsplant-1 (18.8) and seed pod-1 (4.1) , 75 % RDF podsplant-1 (21.3) and seed pod-1 (4.8), 100 % RDFpodsplant-1 (23.7) and seed pod-1 (5.4) , 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation podsplant-1 (25.0) and seed pod-1 (5.6) , 75 % RDF + PSB @ 600 g ha-1 seed inoculation podsplant-1 (24.7) and seed pod-1 (5.4), 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1 podsplant-1 (26.0) and seed pod-1 (5.6) , 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage podsplant-1 (25.4) and seed pod-1 (6.3), 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage + Rhizobium @ 600 g ha-1 podsplant-1 (28.8) and seed pod-1 (6.6), 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage + PSB @ 600 g ha-1 podsplant-1 (28.5) and seed pod-1 (6.4) of urdbean.

The maximum seed yield (1269), straw yield (1512) and biological yield (1407) kg ha-1 were recorded with application of 75% RDF + 0.1 % FeSO4 + 0.5 % ZnSO4foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1seed inoculationas compared to tocontrol (605, 802 and 1407kg ha-1), 75 % RDF (733, 930 and 1664kg ha-1), 100 % RDF (817, 1035 and 1852kg ha-1), 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation (867,1098and 1965kg ha-1), 75 % RDF + PSB @ 600 g ha-1 seed inoculation (854, 1087 and 1941kg ha-1), 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1 (881, 1116 and 1997kg ha-1), 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage (902, 1150 and 2052 kg ha-1), 75 % RDF + 0.1 % FeSO4 + 0.5 % ZnSO4 at pre flowering and pod formation stage + Rhizobium @ 600 g ha-1 (1004,1242 and 2246 kg ha-

1), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage + PSB @ 600 g ha-1 (993, 1254 and 2247kg ha-1) seed, straw and biological yields of urdbean.

The significant improvement in seed yield under the influence of the application of Fe, Zn, and bio-fertilizers was largely a function of improved growth and the consequent increase in different yield attributes [13]. It might also be due to the availability of nutrients to the urban crop which increased number of pods plant-1. This might have significantly increased the number of pods plant-1. Similar results were also reported by [14] for a number of pods of chickpeas when nutrients applied at the initial stages, might have been effectively absorbed and translocated to the pods resulting in a greater number of pods plant-1. A similar result was also found by [15]. The result showed that test weight was not significantly influenced by the different treatments due to an adequate supply of zinc and iron contributed to accelerating the enzymatic activity and auxin metabolism in plants, as auxins are involved in cell division and root formation resulted in a greater number of pods plant-1 and number of seeds pod-1. These results are in close conformity with those of [12], who reported a significant increase in the number of pods plant-1 and number of seeds pod-1 in urban due to the application of zinc and iron. The profound influence of nutrient application on biological yield seems to be on account of its influence on vegetative and reproductive growth [16]. The increase in growth attributes due to application of 75% RDF might have improved the yield parameters of a black gram [17]. Application of Rhizobium and PSB significantly increased pods plant-1, seeds pod-1 as well as seed, straw and biological yield over absolute control due to the fact that Rhizobium inoculation increased the root nodulation through better root development and more nutrient availability ultimately there was a beneficial effect on seed yield. The test weight and harvest index remain non-significant due to the application of different biofertilizers. The findings of this investigation confirm the observations of earlier workers, [18] and [19]. The significant increase in yield due to zinc and iron fertilization could be attributed to the increased plant growth and biomass production, possibly as a result of the uptake of nutrients. These findings are supported by [20] and [12] in various crops.

Effect of Fe, Zn and Biofertilizer on quality

The data about protein content (%) in seed as influenced by the application of Fe, Zn and Bio-fertilizers was presented in Table 1.0. Significantly higher protein content in urdbean seed (24.19%) and protein yield (308.5 kg ha-1)were noted under application of 75% RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1 seed inoculation overcontrol (10.38%) and (62.7 kg ha-1), 75 % RDF (12.13 %) and (89.1 kg ha-1), 100 % RDF (15.31%) and (125.0 kg ha-1), 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation (15.56%) and (133.7 kg ha-1), 75 % RDF + PSB @ 600 g ha-1 seed inoculation (15.38 %) and (131.5 kg ha-1), 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1 (15.81%) and(143.3 kg ha-1), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage (15.75%) and(138.7 kg ha-1), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage + Rhizobium @ 600 g ha-1 (19.44%) and(195.3 kg ha-1), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage + PSB @ 600 g ha-1 (18.69%) and (185.7 kg ha-1)protein content and protein yield of urdbean seed.

A significant increase in protein concentration has been observed in the present investigation because of increased nitrogen concentration in the seed which might be the result of increased availability of nitrogen to plants. The same explanation may be applied to nitrogen content in grain and stover. An improved metabolism to greater translocation of these nutrients to reproductive organs of the crop and ultimately increased the content in seed and stover. These results are in close conformity with those of [21]. Protein yield is a function of protein content in grain and grain yield ha-1. Higher accumulation of photosynthates and nitrogen uptake proved the way for higher protein yields [22]. It might be due to the higher uptake as well as mobilization of nitrogen resulting in enhanced synthesis of amino acids and thereby higher protein content in seeds. The results are in conformation with the findings of [23] in mungbean.

Effect of Fe, Zn and Biofertilizer on monetary returns

A perusal of data indicated that presented in table 1.0 the significant influences net returns and B:C ratio of urdbean under various treatments.

The maximum net returns (₹ 81964/-) and B:C ratio (3.44) were recorded under application of 75% RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ foliar spray at pre flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1 seed inoculation overcontrol (₹39298/- ha-1) and (1.80), 75 % RDF (₹47521/- ha-1) and (2.01), 100 % RDF (₹52933/- ha-1)and (2.19), 75 % RDF + Rhizobium @ 600 g ha-1 seed inoculation (₹56186/- ha-1) and (2.38), 75 % RDF + PSB @ 600 g ha-1 seed inoculation (₹55334/- ha-1) and (2.34), 75 % RDF + Rhizobium @ 600g ha-1 + PSB @ 600 g ha-1 (₹58464/- ha-1) and(2.47), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage (₹57102/- ha-1) and(2.41), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage + Rhizobium @ 600 g ha-1 (₹64950/- ha-1) and(2.73), 75 % RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage + PSB @ 600 g ha-1 (₹62287/- ha-1) and (2.70)net returnsand B:C ratio.

The computation of cost of cultivation is important because it decides the option for the farmers to choose the production practices, according to their investment capacity[24]. The higher net returns and B:C ratio were associated with its higher grain and haulm yield per unit of added cost [25]. Similar finding reported earlier by [26] and [27].

CONCLUSION

Based on one year of experimentation results concluded that urban fertilized with 75% RDF + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$foliar spray at pre-flowering and pod formation stage + Rhizobium 600 g ha-1+ PSB @ 600 g ha-1 seed inoculation was found beneficial for improving seed yield and quality of urban.

Table 1.0: **Effect of Fe, Zn and Bio-fertilizers application on yield, quality and monetary return ofurdbean.**

Treatments	No. of Pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	Protein content (%)	Protein yield (kg ha^{-1})	Net returns (? ha^{-1})	B:C ratio
T_1: Control	18.8	4.1	33.0	605	802	1407	42.88	10.38	62.7	39298	1.80
T_2: 75 % RDF	21.3	4.8	34.3	733	930	1664	44.10	12.13	89.1	47521	2.01
T_3: 100 % RDF	23.7	5.4	36.6	817	1035	1852	44.26	15.31	125.0	52933	2.19
T_4: T_2 + *Rhizobium* @ 600 g ha^{-1} seed inoculation	25.0	5.6	37.2	867	1098	1965	44.13	15.56	133.7	56186	2.38
T_5: T_2 + PSB @ 600 g ha^{-1} seed inoculation	24.7	5.4	36.7	854	1087	1941	44.03	15.38	131.5	55334	2.34
T_6: T_2 + *Rhizobium* @ 600g ha^{-1} + *PSB* @ 600 g ha^{-1}	26.0	5.6	37.4	881	1116	1997	44.08	15.81	143.3	58461	2.47
T_7: T_2 + 0.1 % $FeSO_4$ + 0.5 % $ZnSO_4$ at pre flowering and pod formation stage	25.4	6.3	39.8	902	1150	2052	44.05	15.75	138.7	57102	2.41
T_8: T_2 + T_7 + *Rhizobium* @ 600 g ha^{-1} seed inoculation	28.8	6.6	41.0	1004	1242	2246	44.75	19.44	195.3	64950	2.73
T_9: T_2 + T_7 +*PSB* @ 600 g ha^{-1} seed inoculation	28.5	6.4	40.2	993	1254	2247	44.17	18.69	185.7	64287	2.70
T_{10}: T_2 +T_7 0 + *Rhizobium* 600 g ha^{-1}+ PSB @ 600 g ha^{-1}seed inoculation	34.2	6.9	43.6	1269	1512	2782	45.63	24.19	308.5	81964	3.44
SEm±	1.35	0.35	1.87	44	60	63	2.04	0.78	12.5	2633	0.11
CD (p=0.05)	4.00	1.04	NS	130	179	188	NS	2.32	37.3	7824	0.33

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