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# Growth and yield of wheat and mustard as influenced by recommended doses of fertilizer and intercropping with citronella (*Cymbopogan winterianus*)

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**Abstract**
A field experiment was carried out during rabi season, 2015-16 at Students Instructional Farm C.S. Azad University of Agriculture and Technology, Kanpur to study Growth and Yield of Wheat and Mustard as Influenced by Recommended Doses of Fertilizer and Intercropping with citronella (*Cymbopogan winterianus*). The experiment was laid out in Randomized block design with 9 treatment of cropping systems with 3 fertility levels i.e. [Sole citronella, Sole Wheat, Sole Mustard, Citronella + Wheat (100%RDF), citronella + Wheat (75%RDF), citronella + Wheat (50%RDF), citronella + Mustard (100%RDF), citronella + Mustard (75%RDF), citronella + Mustard (50%RDF)], were replicated thrice. Significant variation was observed for number of tiller per plant, plant height at 30 DAS and 60 DAS, weight of grain per spike, weight of spike per plant and biological yield of wheat. The maximum no. of tiller per plant (6.33), weight of spike per plant (10.00 g) and biological yield (84.11 q/ha) was recorded in sole wheat, whereas plant height at 30 DAS (28.10 cm), plant height at 60 DAS (67.33 cm), weight of grain per spike (58.00 g) was recorded maximum in citronella+ wheat 100% RDF. The data on dry weight of shoot and harvest index was found to be non-significant. The maximum dry weight of shoot (2.50 g) was recorded in citronella+ wheat 100% RDF and harvest index (44.58) was recorded in citronella + wheat 50% RDF. In case of mustard significant variation was observed for the plant height at maturity, number of seed/sillique, seed yield, and stalk yield, whereas data on plant population and test weight of mustard was found to be non-significant. Maximum plant height at maturity (147.67 cm), number of seed/sillique (10.67), seed yield (13.85 q/ha), stalk yield (44.53 q/ha) and test weight (4.00 g) was observed in case of sole mustard, whereas maximum plant population (6.67) was observed in citronella + mustard 100% RDF.

**Keywords:** Intercropping, Citronella, Growth, Yield, Wheat, Mustard

## Introduction
Agriculture is an important sector of the Indian economy, accounting 13.4% of the Nation's GDP (Anon. 2016-17) [1]. Wheat is a temperate crop grown all over India during rabi season in area of 29.80 million hectares and production of 92.29 MT with productivity of 30.7 q./ha and remarked to second wheat growing country after China (Anon. 2015-16) [2]. Wheat (*Triticum aestivum* L.) is the most world widely cultivated food grain crop among the cereals which provides more than 50 percent calories to the people who mainly depend on it and is the principle food crop in most area of the world and will continue to be the major player in the Indian food sector. It is consume mostly in form of bread as "Chapati" and "Straw" is used for feeding cattle. Mustard (*Brassica juncea*) is an annual oilseed crop belongs to family crucifereae. India is one of the largest producers of rapeseed and mustard in the world. The area of rapeseed and mustard in India is 5.80 million hectare with production is 6.30 MT and productivity 10.89 q./ha (Anon., 2015-16) [2]. The seeds and oil are used as condiment in the preparation of pickles and for flavoring curries and vegetables. The oil is utilized for human consumption throughout northern India for cooking and frying purposes. It is also used in the preparation of hair oil and medicines. Citronella (*Cymbopogon winterianus*) is an aromatic crop belonging to family Poaceae. Citronella is a perennial grass and is propagated by vegetative slips. It grows well under varying soil conditions. Citronella oil have great demand in India. According to FFDC (Fragrance and Flavour Development Centre, Govt. of India, Kannauj) the demand of citronella oil is 620 tonnes per year but the production 480 tonnes per year in India. The country facing deficit of 140 tonnes per year (Anon., 2011-2012) [3]. The increasing importance of natural extracts in recent time has opened up new vistas for green revolution beyond their wide spread use as flavors and fragrance ingredients. Citronella oil is a raw material for production of geranial, citronellal and other similar high value perfumery bases. Citronella oil is widely used in scented soaps, sprays, deodorants, detergent, polishes, mosquito repellents etc.

Intercropping is types of cropping system in which growing of two or more crops simultaneously on same piece of land with a definite row arrangement. It is a technique to increase yield of crop and manage risk by best utilization of resources. For determining workability of inter-cropping, important cereal and pulse crops can be introduced as inter crop with citronella. These crop combinations can be proved to seek risk coverage under present changing climatic scenario (Ansari *et al*., 2015) [4]. The results indicated that different cropping system was found to exhibit significantly variations for growth and yield of citronella as well intercrops. The present experiment was carried out with an object to find out the Growth and Yield of Wheat and Mustard as Influenced by Recommended Doses of Fertilizer and Intercropping with citronella (*Cymbopogan winterianus*).

## Materials and Methods

A field experiment was conducted during rabi season, 2015-16 at Students Instructional Farm (SIF), C.S. Azad University of Agriculture and Technology, Kanpur to study the Growth and Yield of Wheat and Mustard as Influenced by Recommended Doses of Fertilizer and Intercropping with citronella (*Cymbopogan winterianus*). The experiment was laid out in Randomized block design with 9 treatment of cropping systems with 3 fertility levels i.e. [Sole citronella, Sole Wheat, Sole Mustard, Citronella + Wheat (100%RDF), citronella + Wheat (75%RDF), citronella + Wheat (50%RDF), citronella + Mustard (100%RDF), citronella + Mustard (75% RDF), citronella + Mustard (50% RDF)], were replicated in three time. In case of citronella fertilizer i.e. NPK applied @ 150:80:40 kg/ha for 100% RDF, 112.5:60:30 kg/ha for 75% RDF and 75:40:20 for 50% RDF. In case of wheat application of NPK @ 120:60:40 kg/ha for 100% RDF, 90:45:30 kg/ha for 75% RDF and 60:30:20 kg/ha for 50% RDF. In mustard fertilizer i.e. NPK should be applied at the rate 80:40:40 kg/ha for 100% RDF, 60:30:30 kg/ha for 75% RDF and 40:20:20 kg/ha for 50% RDF. The soil of experimental field was sandy loam, slightly alkaline in nature. The soil is low in organic carbon and available nitrogen (260 kg/ha), medium in available phosphorus (17.55kg/ha) and potash (175 kg/ha). Root slips of Citronella variety BIO-13 were used for transplanting. After removing upper sheath the root slips was transplanted in line on 30 July, 2010 at a spacing of 60 × 60 cm. The row ratio of 2:2 were maintained in citronella intercrop plots. Seed of Wheat cv. K-9107 (Deva) was used @ 100 kg/ha. The crop was sown with the help of Desi plough in line at a spacing of 20 cm row to row. Seed of Mustard cv. Urvashi was used @ 5 kg/ha. The crop was sown with the help of Desi plough at a spacing of 40 cm from row to row and 15 cm from plant to plant. For determining the significance of difference caused by different treatments data were subjected to statistical analysis by using ANOVA.

## Result and Discussion

### Effect of different treatments on growth and yield attributes of wheat

Data regarding to growth and yield attributes of wheat depicted in Table 1 found that there was significant difference was observed for number of tiller/plant, plant height, weight of spike/plant, number of grain/spike, biological yield of wheat whereas, data regard with dry weight of shoot and harvest index was non-significant. Number of tiller/plant (6.33), weight of spike/plant (10.00 g), biological yield of wheat (84.11 q./ha) was recorded significantly highest in sole wheat followed by C+W 100% RDF (6.00, 9.33g and 51.13q/ha respectively). Number of tiller per plant was recorded maximum might be due to lack of competition among the plants. Maximum biological recorded in sole wheat treatment over all the intercropping system may be due to more number of plant population and number of tillers in sole wheat crops. Similar finding was reported by Mali *et al*. (2015) [5], Shah and Ahmed (2006) [8]. The data on plant height at 30 DAS (28.10 cm), plant height at 60 DAS (67.33 cm), number of grain per spike (58.00) was recorded significantly maximum in C+W 100% RDF followed by sole wheat (27.67 cm, 63.67 cm and 57.67, respectively). It may be due to the competitive effect and higher uptake of nutrient in intercropping system. The similar finding also reported by Pandey *et al*. (1999) [7], and Maniram *et al*. (2015) [6], Srivastava *et al*. (2016) [11]. Dry weight of shoot (2.50 g) was maximum in C+W 100% RDF followed by sole wheat (2.17 g) and harvest index (44.58%) was observed maximum in C+W 50% RDF followed by sole wheat (41.32%) was non-significant.

### Effect of different treatments on growth and yield attributes of mustard

The data pertaining to growth and yield attributes of mustard presented in Table 2 show significant variation was observed for the plant height at maturity, number of seed/sillique, seed yield, and stalk yield, whereas, data on plant population and test weight of mustard was found to be non-significant. Maximum plant height at maturity (147.67 cm), number of seed/sillique (10.67), seed yield (13.85 q/ha), stalk yield (44.53 q/ha) and test weight (4 g) was observed in case of sole mustard followed by C+M 100% RDF (146.33 cm, 9.67, 7.91q./ha, 24.08 q./ha and 3.67 g, respectively). The similar finding also reported by Srivastava *et al*. (2007) [12], Singh *et al*. (2014) [10] and Sharma *et al* (2015) [9]. Seed yield, and stalk yield of mustard was recorded maximum in Mustard sole treatment over other intercropping system it might be due to highest number of silique/plant and number of seed/silique in sole Mustard crops and lack of competition among the plants. Plant population at harvest (6.67) was recorded maximum in citronella + mustard 100% RDF followed by sole mustard (6.33) was non-significant among the treatment. The results are in accordance with the findings of Srivastava *et al*. (2007) [12].

**Table 1:** Effect of different treatments on growth and yield attributes of wheat.

| Treatment | No. of tiller/plant at ( 30 DAS) | Dry weight of shoot at 30 DAS (g) | Plant height | | Weight of spike/ plant (g) | Number of grain/ spike | Biological yield (q/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| | | | 30 DAS (cm) | 60 DAS (cm) | | | | |
| Wheat sole | 6.33 | 2.17 | 27.67 | 63.33 | 10.00 | 57.67 | 84.11 | 41.32 |
| C+W 100% RDF | 6.00 | 2.50 | 28.10 | 67.33 | 9.33 | 58.00 | 51.13 | 38.78 |
| C+W 75% RDF | 4.00 | 1.50 | 26.84 | 60.94 | 8.17 | 55.33 | 46.18 | 40.55 |
| C+W 50% RDF | 3.00 | 1.20 | 24.67 | 52.67 | 7.00 | 46.00 | 37.90 | 44.58 |
| SE(m)± | 0.44 | 0.41 | 0.33 | 1.02 | 0.55 | 0.72 | 1.58 | 2.97 |
| CD (5%) | 1.56 | NS | 1.17 | 3.61 | 1.94 | 2.54 | 5.56 | NS |

**Table 2:** Effect of different treatments on growth, and yield attributes of Mustard

| Treatment | Plant papulation at harvest(/m$^{2)}$ | Plant height at maturity (cm) | No. of seed/silique | Seed yield (q/ha) | Stalk yield (q/ha) | Test weight(g) |
|---|---|---|---|---|---|---|
| Mustard sole | 6.33 | 147.67 | 10.67 | 13.85 | 44.53 | 4.00 |
| C+M 100% RDF | 6.67 | 146.33 | 9.67 | 7.91 | 24.08 | 3.67 |
| C+M 75% RDF | 5.33 | 145.33 | 9.33 | 6.59 | 21.77 | 3.33 |
| C+M 50% RDF | 6.00 | 140.33 | 8.67 | 5.60 | 19.79 | 3.67 |
| SE (m)± | 0.46 | 0.69 | 0.17 | 1.29 | 2.24 | 0.20 |
| CD (5%) | NS | 2.42 | 0.59 | 4.60 | 7.92 | NS |

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