Original Research Article

Effect of crop specific blended fertilizers on growth and yield of maize (*Zea mays* L.)

ABSTRACT

A Field experiment was conducted during *Rabi*2022-23at Agricultural and Horticultural Research Station, Kathalagere, KSNUAHS, Shivamogga, to study the effect of crop specific blended fertilizers on the growth and yield of maize. The experiment was laid out in Randomized Complete Block Design with ten treatments replicated thrice. Nutrient composition of blended fertilizer used for basal application was 16:18:11:4:1 N:P_2O_5:K_2O:S:Zn and for top dress was 27: 0:13 N:P_2O_5:K_2O. The treatments T_1, T_2, T_3 consisted of application of basal blended fertilizer @ 312.5, 412.5 and 515 kg ha^{-1}, respectively and top dress blended fertilizer @ 237.5, 312.5 and 390 kg ha^{-1}, respectively. Basal blended fertilizer @ 412.5 kg ha^{-1} + top dress of urea at 30 and 45 DAS (T_4), Package of practice (PoP) through straight fertilizer (T_5), PoP through complex fertilizer (T_6), recommended dose through Urea, DAP, MOP and $ZnSO_4$ + top dress of nano urea @ 0.4% at 30 and 45 DAS (T_7), physical blending of Urea, SSP, MOP and $ZnSO_4$ (16:18:11:4:1 N:P:K:S:Zn) for basal and Urea and MOP (27:0:13 N:P:K) for top dress (T_8),farmers' practice (T_9) and absolute control (T_{10}). Among all treatments, theapplication of basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} recorded the maximumplant height (222.4 cm), number of leaves (10.3 $plant^{-1}$), total dry matter accumulation (285.86 g $plant^{-1}$), cob length (21.31 cm), cob girth (18.31 cm), number of kernels per cob (516.57) and test weight (24.22 g) at harvest ascompared to PoP through straight and complex fertilizer and absolute control. The same treatment recorded significantly higher kernel and straw yield (69.51 and 89.36 q ha^{-1}, respectively) in comparison toother treatments but it was on par T_2, T_5 and T_6. The treatment T_3 recorded 27.8% higher yield compared to T_9. In study area the application of basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg $ha^{-1}$is recommended to achieve higher growth and yield of maize.

Keywords: Blended fertilizer;maize; Complex fertilizer; Growth; Yield

1. INTRODUCTION

Maize plays a significant role in global food security due to its wide cultivation and used as a staple food in many parts of the world.It is a nutritious kernel that provides important sources of carbohydrates, proteins and essential vitamins and minerals. The impact of the green revolution on maize cultivation in India has been largely positive. Itled to a significant increase in maize yields, which helped to boost food security and reduce thecountry's dependence on food imports. However, the green revolution alsohad some negative impacts on maize cultivation. The emphasis on high-yielding varieties andhybrids of maize led to a reduction in the diversity of maize cultivars grown in the country.Globally, the crop occupies an area of 201.98 m ha with a production of 1162.35 m t and a productivity of 5.75 t ha [1]. In India, it occupies an area of 9.89 m ha with a production of 31.64 m t and average productivity of 31.99 q ha^1 [2]. Karnataka holds first rank in area (1.72 m ha) and production (5.36 m t) among the maize growing states in India, with average productivity of 31.07 q ha^1 [2].

Nutrients are vital for maintaining and improving crop growth and yield. When nutrient application is not synchronized with crop demand, losses from the soil-plant system are large leading to low fertilizer use efficiency. Lack of efficient crop need based nutrient source of fertilizer is one of major constrains in crop production. In countries like India where imbalanced use of chemical fertilizers already created multi-nutrient deficiencies there is an urgent need to motivate farmers to adopt balanced fertilizer use. Knowledge of intensive soil and crop management technologies are required to manage these constraints and ensure increased crop productivity on a sustainable basis. The repeated cultivation of land with inappropriate farming methods is causing severe depletion of nutrients and soil organic matter, posing a serious threat to agricultural productivity and sustainability. Besides, lack of appropriate fertilizer blends has significant influence on nutrients supply during different growth stages of crop. In fact, response of maize plant to application of nitrogen and phosphorus fertilizers varies from variety to variety, location to location and depends on the availability of the nutrients [12]. To address these issues blended fertilizers arethebest solution.

Blended or customized fertilizers are “multi nutrient carrier designed to contain macro and /or micro nutrient forms, both from inorganic and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop’s nutritional needs, specific to its site, soil and crop stage, validated by a scientific crop model capability developed by an accredited fertilizer manufacturing company”. Cultivation of high yielding maize systems will likely exacerbate the problem of secondary and micronutrient deficiencies, not only because larger amounts are removed, but also because the application of large amounts of N, P and K to achieve higher yield targets often stimulates the deficiency of secondary and micronutrients [9]. Application of essential plant nutrients in optimum quantity and right proportion, through correct method and time of application, is the key to increase and sustain crop production[14]. With this background the experiment was conducted to study the effect of crop specific blended fertilizer on growth and yield of maize.

2. MATERIALS AND METHODS

2.1 Experimental site

The field experiment was conducted during *Rabi* 2022-23at Agricultural and Horticultural Research Station, Kathalagere. The experimental plot was situated at 14° 16' 11'' N latitude and 75°49' 31'' E longitude with an altitude of 665 meters above mean sea level. It is located under the Southern Transition Zone of Karnataka (Zone VII). The experimental soil was sandy loam in texture, acidic in nature (pH 6.3) with a low salt load (EC 0.89 dSm^{-1})[8]. It has medium status for organic carbon (7.13 g kg^{-1}) [18]and available nitrogen (294.3kg ha^{-1})[17].While, the status of available phosphorous (68.43kg ha^{-1}) and available potassium (303.5 kg ha^{-1}) were high and medium[8], respectively.

2.2 Experimental details

The experiment was laid out in a Randomized Complete Block Design with ten treatments replicated thrice with gross plot size 5.4 m x 4.2 m. Treatments included T_1: Basal blended fertilizer @ 312.5 kg ha^{-1} + Top dress of blended fertilizer @ 237.5 kg ha^{-1}, T_2:Basal blended fertilizer @ 412.5 kg ha^{-1}+ Top dress of blended fertilizer @ 312.5 kg ha^{-1}, T_3: Basal blended fertilizer @ 515 kg ha^{-1}+ Top dress of blended fertilizer @ 390 kg ha^{-1}, T_4: Basal blended fertilizer @ 412.5 kg ha^{-1} + Top dress of 50 % RDN through Urea, T_5: Package of practice (PoP)through straight fertilizer (Urea, SSP, MOP) and $ZnSO_4$ + Top dress of 50 % RDN through Urea, T_6: PoP through complex fertilizer (20-20-0-13), MOP and $ZnSO_4$ + Top dress of 50 % RDN through Urea, T_7: PoP through Urea, DAP, MOP and $ZnSO_4$ + Top dress of foliar spray of nano urea @ 0.4 %, T_8: Physical blending of Urea, SSP, MOP and $ZnSO_4$(16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP (27:0:13 N:P:K), T_9: Farmers' practice 37.5 kg Urea ha^{-1}, 187.5 kg DAP ha^{-1}, 50 kg MOP ha^{-1}+ Top dress of 125 kg Urea ha^{-1}, T_{10}: Absolute control.Recommended farm yard manure (10 t ha^{-1}) was applied 15 days before sowing of the crop commonly to all plots except T_{10} (Absolute control). On the day of sowing calculated quantity of basal fertilizer was applied evenly beside the crop rows. In T_1 to T_8 top dress was done at 30 and 45 DAS with specified quantity of fertilizer through different sources of fertilizers. The foliar spray of nano urea (T_7) was done at 30 and 45 DAS @ 0.4 %. In farmers' practice top dress of 125 kg ha^{-1} urea was done at 30 DAS.Blended fertilizer formulated by Zuari Farm hub Limited, Bengaluru was used for the study. Newly formulated blended fertilizer is specific for maize crop grownunder Chitradurga, Davanagere and Shivamogga districts of Karnataka. Nutrient composition of blended fertilizer used for basal application was 16:18:11:4:1 N:P:K:S:Zn and for top dress was 27:0:13 N:P:K.The source of fertilizers used in physical blending of Urea, SSP, MOP and ZnSO4 (16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP (27:0:13 N:P:K) (T_8) was formulated by physically mixing straight fertilizers (Urea, SSP, MOP and $ZnSO_4$) in proportion of 16:18:11:4:1 N:P:K:S:Z as basal and 27:0:13 N:P:K as top dress. The quantity of nutrients supplied in this treatment is equivalent to T_2.In farmers' practice (T_9) thirty farmers from each district were interviewed to know the rate of application of fertilizer to maize. On an average farmers apply 37.5 kg Urea ha^{-1}, 187.5 kg DAP ha^{-1}, 50 kg MOP + Top dress of 125 kg Urea ha^{-1}.

2.3 Collection of experimental data

For recording various biometric observations, sample consisting of five plants were selected at random and tagged in net plot of each treatment. Observations on growth parameters (*i.e*plant height, number of leaves, leaf area) were recorded at different crop growth stages. The same plants were used to record the yield components (cob length, cob diameter, number of kernels cob^{-1}) at harvest. Five plants were selected at random from destructive sampling rows to record dry matter accumulation.

2.4 Statistical analysis

The data recorded on various observations of growth and yield parameters were subjected to analysis of variance (ANOVA) as suggested by [5]. Five per cent level of significance was used in the 'F' test. The critical difference (CD) values were given in the table at 5 per cent level of significance, wherever the 'F' test was significant. Otherwise against CD values abbreviation of NS (Non-significant) was indicated.

3. RESULTS AND DISCUSSION

3.1 Growth parameters

The different growth and yield parameters varied in response to the application of different dose of blended fertilizers (Table 1). The plant height significantly varied from 222.4 cm in the treatment basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} as against least plant height of 111.0 cm was recorded in the absolute control at harvest. The increase in plant height resulting from the application of blended fertilizers can be attributed to the effective nourishment of the crop and optimal crop growth conditions. According to [4]improved nutrients absorption leads to cell elongation and multiplication. Also, application of micronutrients along with major nutrients to the plants might have impacted positively on metabolic processes, resulting in increased activity of meristematic cells and cell elongation.

Nutrient supply plays a significant role in determining the leaf area and rate of total dry matter production. The treatment basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} recorded higher leaf area and dry matter production of 36.79 dm^{2} plant^{-1} and 285.86 g plant^{-1}, respectively. In contrast, lower leaf area and dry matter production was found in absolute control. This might be due to improved crop growth and development by blended fertilizer which contain zinc that increased utilization of applied nutrients by the crop [5]. The result is in agreement with [6]who reported that zinc is closely involved in the nitrogen metabolism of plants which is essential for attaining the optimum leaf area, the most important indicator of size ofthe assimilatory system in maize to maximize harvest of the incidental solar radiation.

Table 1: Influence of blended fertilizers on growth parameters of maize

Treatment	Plant height (cm)	Leaf area (dm^2 $plant^{-1}$)	Total dry matter (g $plant^{-1}$)
	At harvest		
T_1: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 312.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 237.5 kg ha^{-1}	191.3	29.61	183.1
T_2: Basal blended fertilizer (16:18:11:4:1N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 312.5 kg ha^{-1}	214.3	34.72	201.5
T_3: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 515 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 390 kg ha^{-1}	222.4	36.79	208.3
T_4: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of 50 % RDN through Urea	192.6	30.86	183.6
T_5: PoP through straight fertilizer (Urea, SSP, MOP) and $ZnSO_4$ + Top dress of 50 %RDN through Urea	194.4	31.64	186.6
T_6: PoP through complex fertilizer (20-20-0-13), MOP and $ZnSO_4$ + Top dress of 50 % RDN through Urea	210.6	34.19	198.3
T_7: PoP through Urea, DAP, MOP and $ZnSO_4$ + Top dress of foliar spray of nano urea @ 0.4%	186.5	29.29	182.2
T_8: Physical blending of Urea, SSP, MOP and $ZnSO_4$ (16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP(27:0:13N:P:K)	181.7	28.78	178.6
T_9: Farmers' practice 37.5 kg Urea ha^{-1},187.5 kg DAP ha^{-1}, 50 kg MOP ha^{-1} +Top dress of 125 kg Urea ha^{-1}	173.6	25.05	170.4
T_{10}: Absolute control	111.0	12.37	105.8
S. Em. ±	9.8	1.78	8.1
CD (P= 0.05)	29.0	5.30	24.1

3.2 Yield attributes

The highest cob length and cob diameter of 21.31 and 18.31 cm, respectively was recorded in the treatment basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} and absolute control recorded lowest cob length and cob diameter of 11.21 and 8.93 cm, respectively (Table 2). Also, the same treatment (T_3) recorded higher number of kernels per cob (516.57). Abundant supply of nutrients through blended fertilizers might have increased the protoplasmic constituents and accelerated the process of cell division and elongation. This in turn resulted in increased corn yield components. Similar results were reported by [10], [11] and [13]. Also, sulphur is mainly responsible for nitrogen availability hence with the increasing rate of sulphur, the availability of nitrogen and its uptake increases thus resulting in higher yield [3].

The test weight of maize kernel was non-significant (Table 2) across different treatments tested. It might be due to the genetic trait responsible for mobilization of resource from source towards the sink. This genetic characteristic exhibits remarkable stability and remains unaffected by external factors, thereby explaining its insignificant variation**.**

3.3 Kernel yield

The maximum kernel yield (69.51 q ha^{-1}) was recorded in treatment with application of basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} which statistically on par with basal blended fertilizer @ 412.5 kg ha^{-1} + Top dress of blended fertilizer @ 312.5 kg ha^{-1} (67.80 q ha^{-1}) (Table 3). Also, Application of basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1} recorded higher stover yield (89.30 q ha^{-1}) this may be due to the greater contribution of nutrients from blended fertilizer which enables the plant to develop a more extensive root system to extract water and nutrients, from deeper layer. In addition, it could be also be attributed due to the beneficial effect of yield contributing characters and positive interaction of nutrients in the blended fertilizer. Hence the application of blended fertilizer as soil fertility management practices from this demonstration confirmed that the necessity of N:P:K:S:Znfertilizer for the improvement of yield attributes and yield of maize crop these results are in line with [3]who identified that application of blended fertilizer was significantly improved the weights of the kernels, total above ground dry biomass yield and kernel yield when compared with control plots. These results are in line with the findings of [10]and[13]. The lower kernel yield (27.67 q ha^{-1}) in absolute control might be due to reduced leaf area development resulting in lesser radiation interception and consequently, low efficiency in the conversion of solar radiation [15]. Yield obtained in absolute control is comparatively high inspite of not applying any nutrients while, the better performance of the crop under absolute control could be attributed due to higher initial available soil nutrients

The harvest index (HI) is a derived factor. It was noted that there was no significant difference (Table 3) in the HI values across various treatments. This lack of significant variance can be attributed to the fact that changes in kernel yield and straw yield are interconnected. Consequently, treatment with increase in these yields occurs at a nearly equivalent rate [16].

The kernel yield recorded by different treatments under study was compared with farmers' practice (T_9). In comparison with farmers' practice higher per cent of increase in grain yield (Fig.1) was noticed in the treatment with application of basal blended fertilizer @ 515 kg ha^{-1}+ Top dress of blended fertilizer @ 390 kg ha^{-1} (27.87 %) and next in the order of basal blended fertilizer @ 412.5 kg ha^{-1} + Top dress of blended fertilizer @ 312.5 kg ha^{-1} (24.72 %), PoP through complex fertilizer (20-20-0-13), MOP and $ZnSO_4$ + Top dress of 50 % RDN (18.74%) and PoP through straight fertilizer (Urea, SSP, MOP) and $ZnSO_4$ + Top dress of 50 % RDN (18.38 %), basal blended fertilizer @ 412.5 kg ha^{-1} + Top dress of 50% RDN (14.59 %), basal blended fertilizer @ 312.5 kg ha^{-1} + Top dress of blended fertilizer @ 237.5 kg ha^{-1} (12.56 %), PoP through Urea, DAP, MOP and $ZnSO_4$ + Top dress of foliar spray of nano urea @ 0.4 % (8.92 %), Physical blending of Urea, SSP, MOP and $ZnSO_4$ (16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP (27:0:13 N:P:K) (8.46 %).

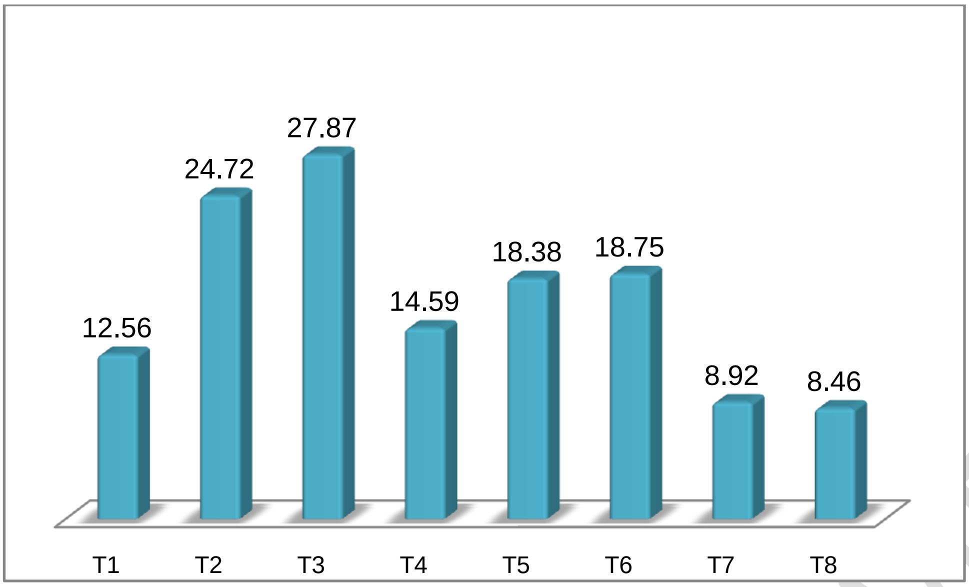

Fig. 1. Per cent Increase in kernel yield ascompared to farmers' practice

Note: Treatment details are provided in materials and methods

4. CONCLUSION

The results of present investigation clearly evident that the application of blended fertilizer significantly influenced on both growth and yield parameters. So, application of blended basal blended fertilizer @ 515 kg ha^{-1} + Top dress of blended fertilizer @ 390 kg ha^{-1}could be recommended for the maize crop growth under Southern Transition Zone of Karnataka.

Table 2: Influence of blended fertilizers on yield attributing traitsof maize

Treatment	Cob length (cm)	Cob girth (cm)	Test weight (g)	Number of kernels cob^{-1}
	At harvest			
T_1: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 312.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 237.5 kg ha^{-1}	17.63	15.68	23.65	467.78
T_2: Basal blended fertilizer (16:18:11:4:1N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 312.5 kg ha^{-1}	20.77	17.76	24.18	504.52
T_3: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 515 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 390 kg ha^{-1}	21.31	18.31	24.22	516.57
T_4: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of 50 % RDN through Urea	17.89	16.43	23.81	471.09
T_5: PoP through straight fertilizer (Urea, SSP, MOP) and $ZnSO_4$ + Top dress of 50 %RDN through Urea	18.74	16.56	23.90	484.67
T_6: PoP through complex fertilizer (20-20-0-13), MOP and $ZnSO_4$ + Top dress of 50 % RDN through Urea	20.43	17.02	23.86	487.32
T_7: PoP through Urea, DAP, MOP and $ZnSO_4$ + Top dress of foliar spray of nano urea @ 0.4%	16.78	15.11	23.55	452.58
T_8: Physical blending of Urea, SSP, MOP and $ZnSO_4$ (16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP(27:0:13N:P:K)	16.19	14.59	23.63	449.05
T_9: Farmers' practice 37.5 kg Urea ha^{-1},187.5 kg DAP ha^{-1}, 50 kg MOP ha^{-1} +Top dress of 125 kg Urea ha^{-1}	15.73	13.92	23.61	413.96
T_{10}: Absolute control	11.21	8.93	23.34	213.75
S. Em. ±	0.95	0.60	0.23	15.16
CD (P= 0.05)	2.81	1.79	NS	45.05

Table 3: Influence of blended fertilizers on yield of maize

Treatment	Kernelyield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 312.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 237.5 kg ha^{-1}	61.19	76.24	44.71
T_2: Basal blended fertilizer (16:18:11:4:1N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 312.5 kg ha^{-1}	67.80	87.91	43.54
T_3: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 515 kg ha^{-1} + Top dress of blended fertilizer (27:0:13N:P:K) @ 390 kg ha^{-1}	69.51	89.36	43.81
T_4: Basal blended fertilizer (16:18:11:4:1 N:P:K:S:Zn) @ 412.5 kg ha^{-1} + Top dress of 50 % RDN through Urea	62.29	76.87	44.85
T_5: PoP through straight fertilizer (Urea, SSP, MOP) and $ZnSO_4$ + Top dress of 50 %RDN through Urea	64.35	77.83	45.27
T_6: PoP through complex fertilizer (20-20-0-13), MOP and $ZnSO_4$ + Top dress of 50 % RDN through Urea	64.55	87.52	42.43
T_7: PoP through Urea, DAP, MOP and $ZnSO_4$ + Top dress of foliar spray of nano urea @ 0.4%	59.21	75.57	44.09
T_8: Physical blending of Urea, SSP, MOP and $ZnSO_4$ (16:18:11:4:1 N:P:K:S:Zn) + Top dress through physical blending of Urea and MOP(27:0:13N:P:K)	58.96	75.08	43.92
T_9: Farmers' practice 37.5 kg Urea ha^{-1},187.5 kg DAP ha^{-1}, 50 kg MOP ha^{-1} +Top dress of 125 kg Urea ha^{-1}	54.36	70.76	43.58
T_{10}: Absolute control	27.67	43.04	39.39
S. Em. ±	2.15	3.93	1.44
CD (P= 0.05)	6.39	11.67	NS

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