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NAMIBIAN AGRONOMIC BOARD
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AN OVERVIEW ON THE PERFORMANCE OF NEW PEARL MILLET VARIETIES *(Pennisetum glaucum)* IN NAMIBIA - 2022

ABSTRACT

Pearl millet is an important staple crop that is cultivated in Namibia, whose yield is partially hampered by the limited availability of high-yielding adapted improved varieties. The certified seed sector in Namibia is underdeveloped, thus resulting in high dependence on traditional seed varieties (Landraces) and food imports. To widen the range of and access to improved seed varieties that are high-yielding and well-adapted to the Namibian soil and climatic conditions, the Namibian Agronomic Board (NAB) and the University of Namibia (UNAM) jointly undertook an experimental research trial on pearl millet. The experimental field trials of early and intermediate maturing pearl millet varieties were conducted over two consecutive cropping seasons during 2020/2021 and 2021/2022 to identify new high-yielding pearl millet varieties that can be multiplied and released to local farmers. The trials were conducted under a rainfed cropping system although few sites were supplemented with irrigation during prolonged dry spells after planting. This trial used a balanced incomplete block alpha experimental design, with two replications at each research production site. Data on growth and yield parameters were collected. In 2020/21, 24 new pearl millet varieties were tested in four sites together with Okashana no. 2, Kangara (improved local), and Kantana (improved local). Results showed that ten (10) new pearl millet varieties outperformed Okashana no. 2 and Kangara. In 2021/22, fresh seeds of the best ten (10) varieties were sourced and planted alongside the local varieties of pearl millet. Season 2 results showed that two (2) of the new pearl millet varieties outperformed Okashana no. 2, the best of the local varieties available in Namibia, three (3) outperformed Kangara (improved local), and Kantana was the least performer of all varieties tested in both Seasons 1 and 2. Based on crop performance in Season 2, three (3) new best-performing pearl millet varieties namely, SOSAT C88, IP 17645, and 18948 displayed prospects of cultivation in Namibia with promising yield under Namibian soil and climatic conditions, thus they are recommended for cultivation in Namibia to supplement the local varieties.

Key words: Pearl millet, performance, yield, days to maturity, adaptability

1. INTRODUCTION

Pearl millet is a staple food crop in Namibia. The availability of quality seeds of locally adapted food security crop varieties in Namibia is limited and local farmers have been recording far below the average yield of fewer than 0.3 tons per ha of pearl millet (Ipinge, 1998). Thus, the introduction of pearl millet seeds of suitable varieties (high yielding and adapted to the local climatic and field conditions) is a critical step towards expanding local production and increasing varietal selection options for local farmers.

The University of Namibia (UNAM) and the Namibian Agronomic Board (NAB) are implementing a 5-year MOU on Seed Research and Seed Production of selected agronomic and horticulture crops including pearl millet. The aim is to develop high-yielding adapted varieties of food security crops that feed into the mainstream seed and food production systems. The two institutions (NAB & UNAM) undertook experimental research trials on pearl millet during two cropping seasons (2020/2021 & 2021/2022) to identify new high-yielding pearl millet varieties that can be multiplied and released to local farmers respectively.

In the 2020/2021 cropping season, twenty-four (24) new pearl millet varieties acquired from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Nairobi, Kenya, were tested in four (4) sites in Namibia together with local checks (Kangara (local improved), Kantana (local unimproved), and Okashana no. 2 (local improved)). At the end of the first cropping season, ten (10) new varieties were selected based on their average performance in four (4) sites. In the 2021/2022 cropping season, pure seed (not contaminated by external (pollen) of the ten (10) varieties selected in Season 1 were planted in five (5) sites. At the end of Season 2, three (3) new pearl millet varieties were selected based on their high performance in Namibia. These three (3) pearl millet varieties are being recommended for adoption in Namibia.

These three selected varieties - *SOSAT C88*, *IP 17645,* and *18948* with two (2) runners-up MS 2 and MS 11, were planted at the Doringboom research production site for the third season and seed multiplication.

This article, therefore, highlights the performance results of pure seeds of the new pearl millet varieties, with emphasis on the best varieties which outperformed the local varieties in both Season One (2020/21) and Two (2021/22) with more focus on the best performing ten (10) varieties and the selected three (3) varieties recommended for adoption. The results highlighted in this article are aggregated and not per specific site or production zone. Therefore, the article details more on the overall best-performing varieties from both cropping seasons of the trial. Detailed results per site will also be made available at a later stage.

2. METHODOLOGY

The Season Two experimental trial was planted at five research production sites covering four different agroecological zones or four production zones, namely, Central, North Central, Kavango, and Zambezi. These are Doringboom (Otjozondjupa region), UNAM - Ogongo Campus (Omusati region), Mashare Irrigation PTY (Kavango East region), Rupara Agricultural Development Centre (Kavango West region), and Zambezi Vocational Training Centre (Zambezi region). The objective was to assess the performance of new pearl millet varieties under Namibian abiotic and biotic environments.

The trial was laid out as a balanced incomplete block alpha design and treatments were randomly assigned to incomplete blocks. Each field experimental site was divided into two replications, except in Mashare and Zambezi VTC where the treatments were repeated for times. Replications at Mashare and Zambezi VTC were increased due to the excess availability of land and seeds. This was to allow the identification of statistically smaller differences in treatment means that could not be identified with fewer replications.

Each replication had 13 plots of 31.5m^2 (5.25 × 6m^2) each, with 1m paths between plots and 2m paths between incomplete blocks. The trial was planted under a rainfed production system although supplementary irrigation was applied in the first cropping season during dry spells at Mashare, Ogongo, Doringboom, and Zambezi VTC sites. At sites where irrigation was supplemented, irrigation was done minimally only after planting but was suspended immediately when rain resumed.

The results were analysed using a uniform method across all sites as the irrigation supplement that was done to some sites was quite insignificant and was done at the very early stages of the plant growth. No irrigation was done under farm field conditions (rainfed). Average means were then calculated across all sites, thus, only average means results are presented in this paper.

3. RESULTS AND DISCUSSIONS

3.1. Growth duration (Number of days to 50% flowering date)

Three new varieties, namely, ICMP 177003, SOSAT C88, and 41518/K16 recorded the shortest number of days to 50% flowering between 52, 55, and 57 days after planting respectively. These three varieties reached 50% flowering stage earlier than all local varieties (Okashana no. 2, Kangara, and Kantana). The other remaining seven new pearl millet varieties reached the 50% flowering stage between 59 and 65 days after planting. These seven varieties reached 50% flowering stage later than the two local varieties, Okashana no. 2 and Kangara, which reached 50% flowering stage at 57 and 60 days respectively.

However, Kantana the local variety, recorded the longest number of days, 83 days to 50% flowering stage as illustrated in Figure 1 below. Days to 50% flowering is the number of days taken from the date of sowing to when 50% of the florets have pollen visibly sticking out. Early-maturing varieties tend to form seeds early and avoid late-season drought, therefore, obtain higher yields in drought-prone areas than late-maturing varieties.

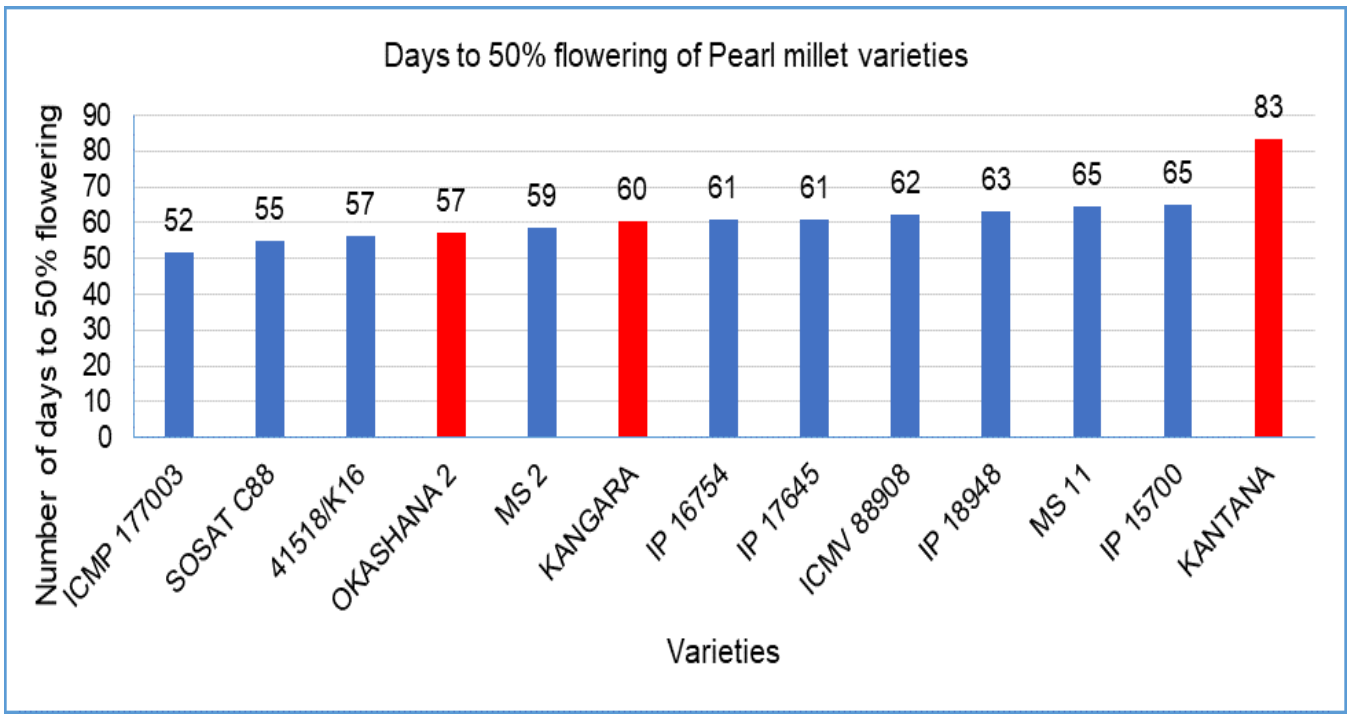

Figure 1: Number of days to 50% flowering of pearl millet varieties

3.2. Grain yield and agronomic score

3.2.1 Grain yield (t/ha)

Bird damage was an important contributor to grain yield as determined by correlation analysis. The higher the bird damage, the lower the yield, and vice versa. The percentage of heads not eaten by birds and the percentage of heads with no grains also determined the number of grains harvested. Overall, two new varieties, SOSAT C88 (2.12 t/ha) and IP 17645 (2.10 t/ha) were on average better than Okashana no. 2 (1.94 t/ha) (improved local).

These, together with IP 18948 (1.90 t/ha), were better than Kangara (1.87 t/ha) (improved local) (Figure 2). However, the 41518/K16 new pearl millet variety, which has poor germination recorded the lowest yield below all varieties tested including all three local varieties. Kantana recorded poor yield performance. A comparative evaluation of varietal yield performance in Season one and Season two are presented in Table 1.

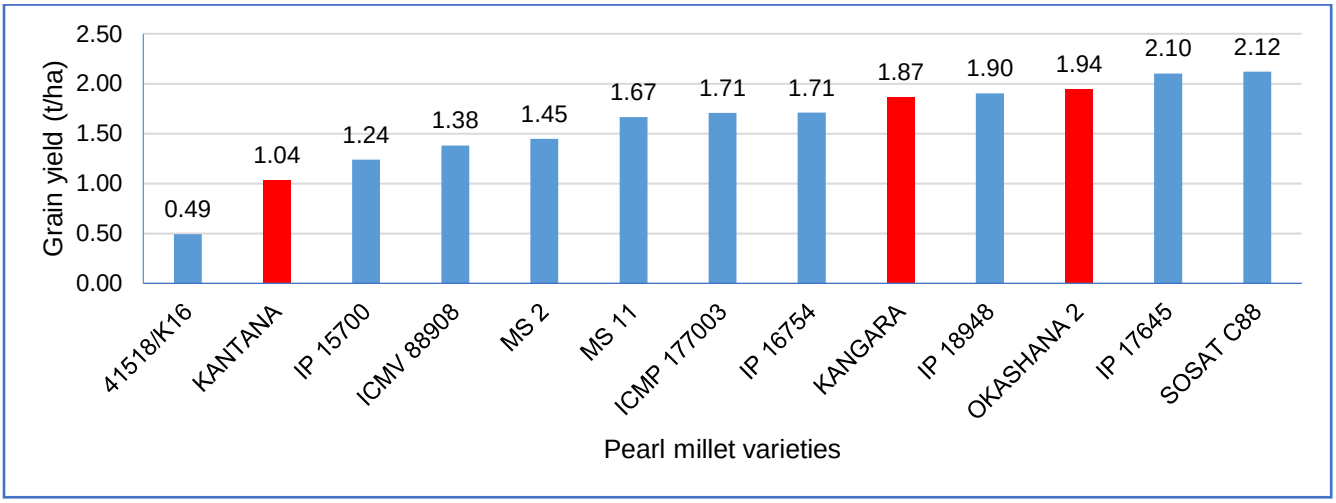

Figure 2: Average grain yield (t/ha) of pearl millet varieties - Agronomic score

3.2.2 Agronomic score

The agronomic score is defined as the overall performance of a variety on a scale of 1 – 5 based on visual impression before harvesting where varieties with the greatest phenotypic performance were scored one and the worse were scored five. Crop experts and well-experienced farmers visually inspect the crops by looking at the crop establishment, plant structural development, vigour, and colour. There is a strong correlation between yield observation and agronomic score. Pearl millet variety 41518/K16 recorded a worse score of 3.5 while Okashana no. 2 the local pearl millet variety recorded the best score of 1.5 (Figure 3). It is important to note that the poor score given to 41518/K16 was biased due to very poor germination.

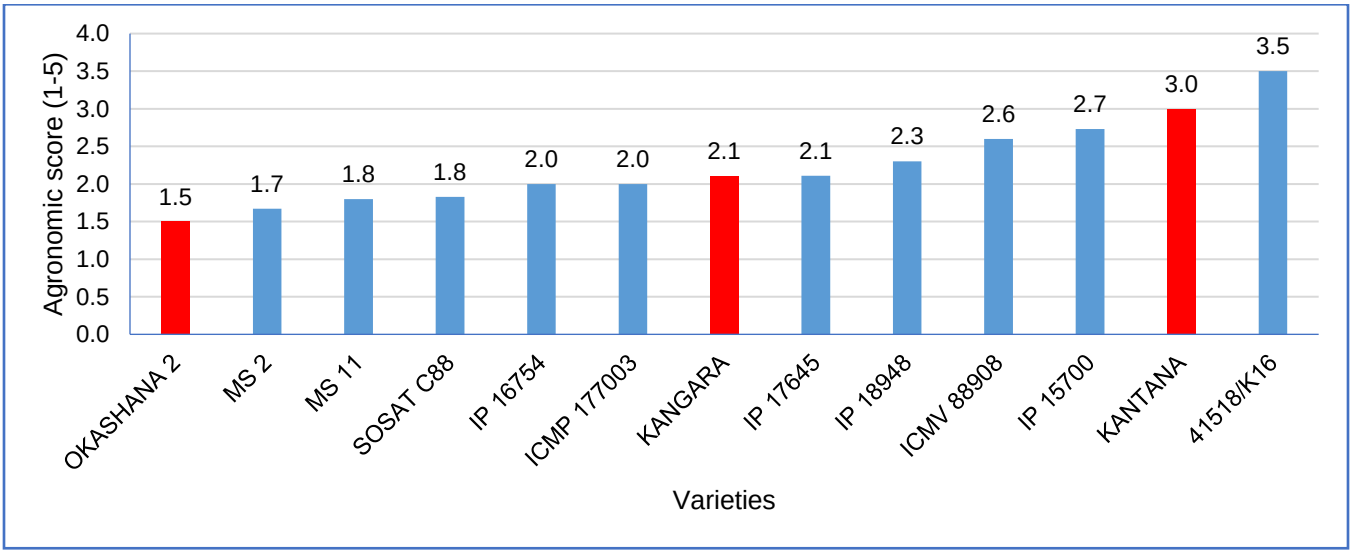

Figure 3: Agronomic score (1-5) of pearl millet varieties (where 1 is best and 5 is worse)
Key: 1 = Very good; 2 = Good; 3 = Average; 4 = Below Average; and 5= Poor

3.3. Dry biomass yield and plant height

3.3.1 Dry biomass yield

Kantana the local variety recorded the highest biomass yield of 10.8 tons/ha while 41518/K16 recorded the lowest biomass yield of 1.6 tons per ha (see Figure 4 below).

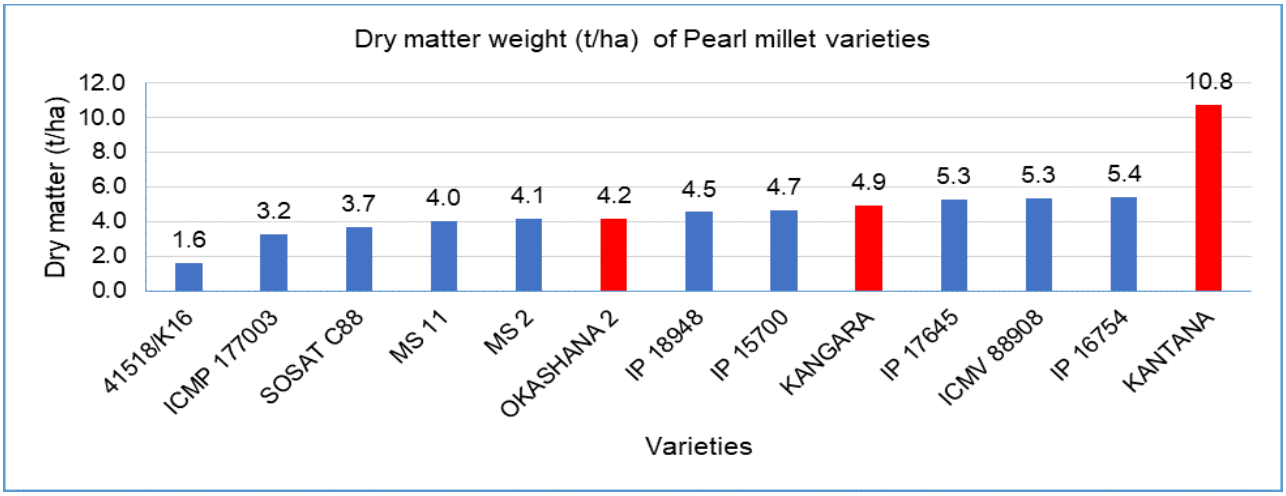

Figure 4: Dry biomass yield (t/ha) of pearl millet varieties

The results show that dry biomass yield has a positive correlation with plant height as illustrated in Figure 5 below.

3.3.2 Plant height

Figure 5 shows that Kantana, the local variety, remains the tallest variety with 261 cm while Okashana was among the shortest varieties and 41518/K16 and recorded the shortest height of 141 cm. A variety with a high dry biomass yield possesses a positive indication of use for animal fodder and high organic content for soil fertility.

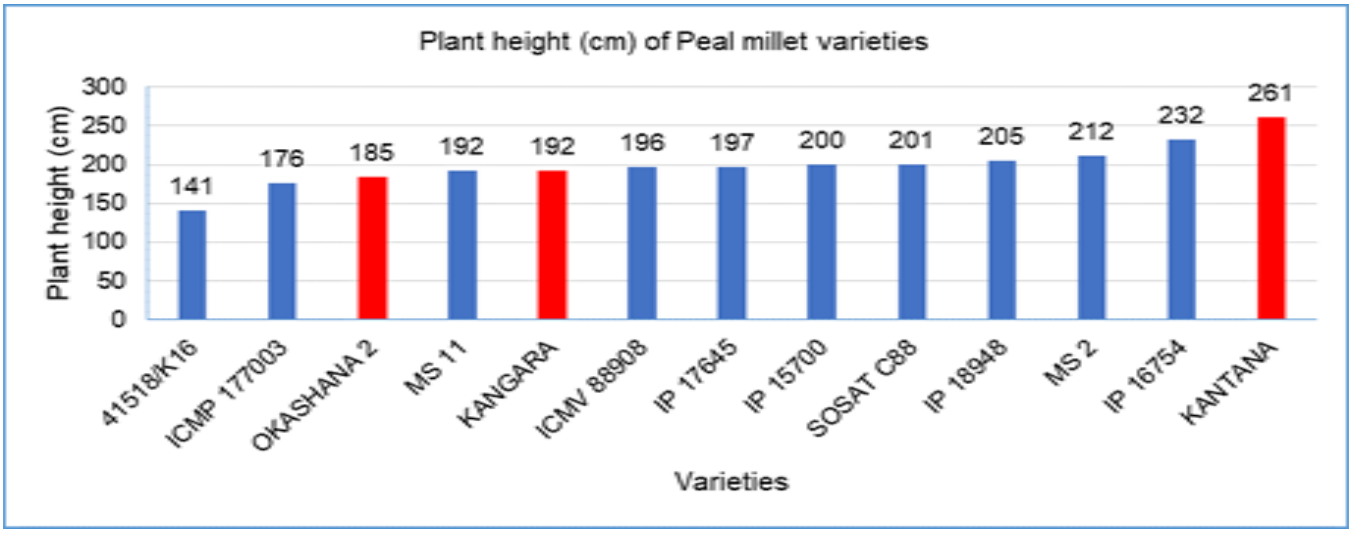

Figure 5: Plant height (cm) of pearl millet varieties

3.4. Number of tillers and number of productive tillers per plant

3.4.1 Number of tillers per plant

On average, Kantana, which is the tallest variety under test, had the least number of tillers per plant (6.3), while ICMP 177003, one of the shortest varieties, had the highest number of tillers per plant (9.6) (Figure 6). Shorter varieties, therefore, tend to have more tillers and vice versa, as taller plants have appropriate resources for apical growth than tillering.

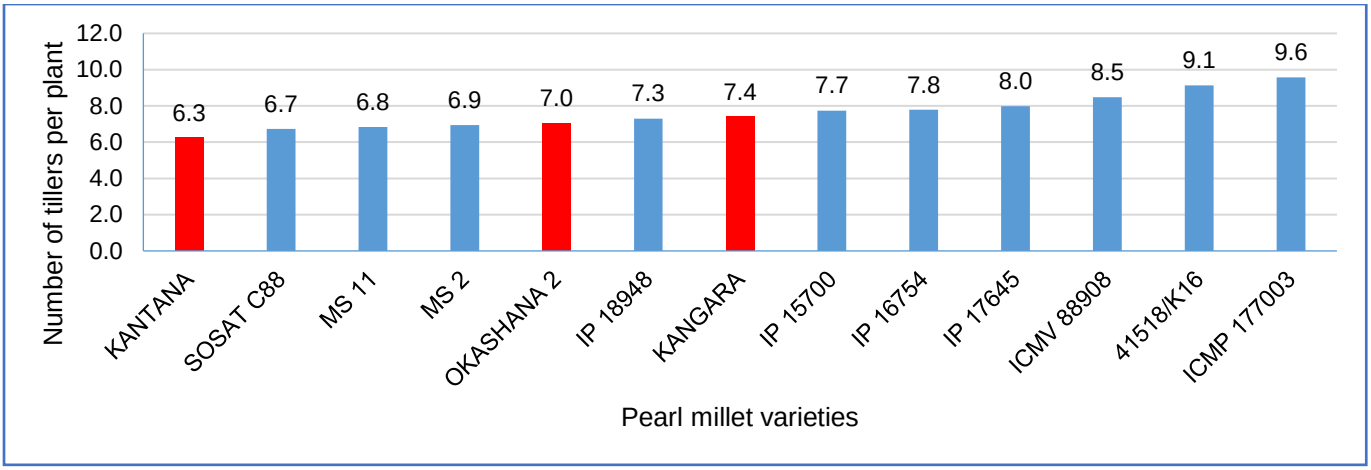

Figure 6: Average number of tillers per plant

3.4.2 Number of productive tillers

Not all tillers were productive (head bearing), hence the need to account for the fate of each tiller/shoot. A comparison of the total number of tillers per plant and the number of productive tillers per plant (Figures 6 and 7) showed that 77% and 75% of all tillers in Okashana no. 2 and Kangara respectively had heads. This shows a higher ability of these varieties to form heads in most of their tillers. In the case of Kantana, about half of the tillers contained heads, while the rest of the shoots were headless. Pearl millet varieties with more headless tillers are therefore more suitable for biomass than for grains.

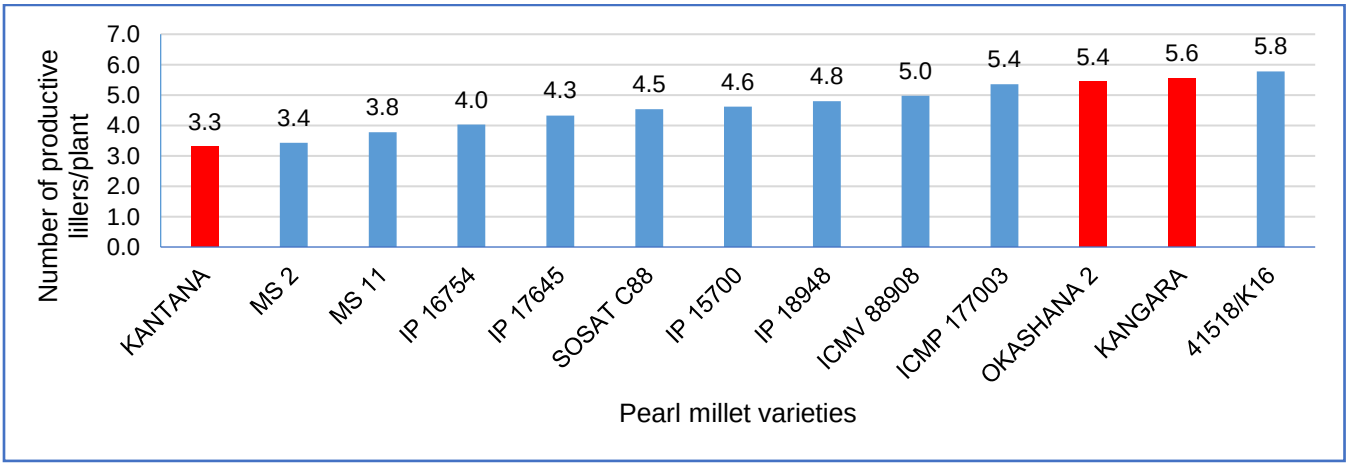

Figure 7: Average number of productive tillers per plant for pearl millet varieties in three sites

3.5. Bird damage

Bird damage determines the number of seeds in a head, hence the yield. SOSAT C88, IP 17645, and ICMP 177003 had the least bird damage, while Kantana was the most damaged. Being a tall and late-maturing variety made Kantana available and hence vulnerable to bird attack when the heads of most other varieties had dried up (Figure 9).

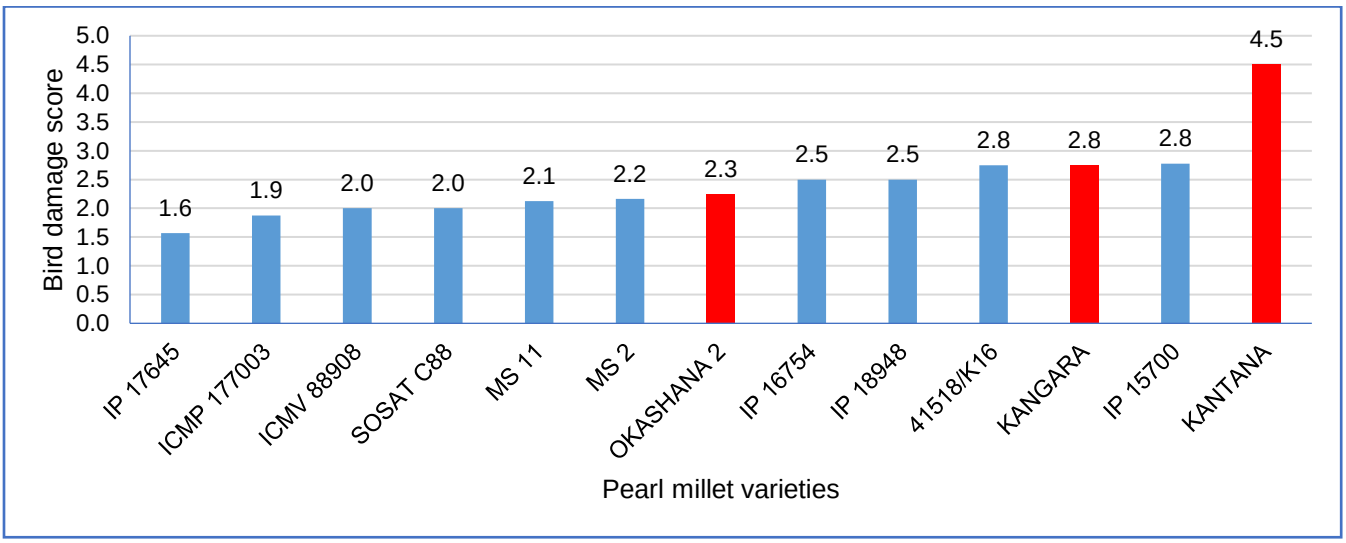

Figure 8: Average bird damage score on pearl millet heads in three sites
Key: *1 = Slight or no damage; 2 -3 = Moderate damage; 4-5 = Severe damage*

3.6 Summary of pearl millet characteristics and Yields

Table 1 summarises the characteristics and grain yield of pearl millet varieties in descending order while indicating the yields per cropping/trial season and maturity periods.

Table 1: Summary of characteristics of pearl millet varieties ranked in terms of grain yield (t/ha) (in descending order)

Season 2 Rank	Variety	Season 1 Average grain yield (t/ha)	Season 2 Average grain yield (t/ha)	Comparative performance in Season 1 and Season 2	Maturity	Farmers' preference statements (score)
1	SOSAT C88	2.70	2.12	Season 2 -1st overall best Season 1 - 4th best overall	Early	Good heads, clean heads with more grains (1)
2	IP 17645	2.44	2.10	Season 2 - 2nd overall best Season 1 - 9th best overall	Early/Intermediate	Compact heads with small grain, not eaten by birds (3)
3 - Reference	OKASHANA 2	2.09	1.94	Season 2 - 3rd overall Season 1 - 21st position	Early maturing	Medium compact heads
4	IP 18948	2.68	1.90	Season 2 - 4th overall best Season 1 - 5th best overall	Intermediate	Big heads, big grains (1)
5 - Reference	KANGARA	1.99	1.87	Season 2 - 5th overall best Season 1 - 23rd position	Early	Fast maturing, short heads (2)
6	IP 16754	2.65	1.71	Season 2 - 6th best overall Season 1 - 6th best overall	Intermediate	Long heads, few grains/poor seed set
7	ICMP 177003	2.85	1.71	Season 2 - 7th overall best Season 1 - 1st overall	Early	Small compact heads, easily damaged by rain (4)

8	MS 11	2.39	1.67	Season 2 - 8th best overall Season 1 - 10th best overall	Intermediate	Big grains, compact heads (4)
9	MS 2	2.45	1.45	Season 2 - 9th best overall Season 1 - 8th overall	Early	Stems are thin and can easily break Compact heads (3)
10	ICMV 88908	2.65	1.38	Season 2 - 10th best overall Season 1 - 7th best overall	Intermediate	Long heads (3)
11	IP 15700	2.82	1.24	Season 2 - 11th best overall Season 1 - 2nd best overall	Late maturing	Long heads (2)
12 - Reference	KANTANA	1.72	1.04	Season 2 - 12th position Season 1 - 25th position (last overall)	Late maturing	Good growth but very poor seed set
13	41518/K16	2.70	0.49	Season 2 - 13th - last overall Season 1 - 3rd best overall	Intermediate	Short, poor germination, fat heads, big grains (3)
	Average	**2.25**	**1.59**			**1 – best, 5 - worst**

4. CONCLUSION AND RECOMMENDATIONS

With the current limited availability of high-yielding adapted improved pearl millet varieties and the underdeveloped Namibian seed sector, these results create new prospects for local pearl millet growers. The two (2) new varieties, SOSAT C8 (2.12 t/ha) and IP 17645 (2.10 t/ha), performed better than Okashana 2 (1.94 t/ha) (improved local) and also attained a high average yield of over two tons per ha. IP 198948 (1.90 t/ha) performed better than Kangara (1.87 t/ha) (improved local), while Kantana was one of the least performers (1.04 t/ha).

Most tall and late-maturing varieties attained lower yields and they were easily affected by birds. Hence, they did not make it into the top best three varieties. Overall, the highest best-performing new pearl millet varieties attained over 2.12 tons/ha average yield which is higher than the current local average yield of lower than 0.3 tons per ha under rainfed. The new varieties were exposed to a dry land cropping system in harsh Namibian weather conditions for two consecutive seasons, thereby enabling comprehensive observation. The best-performing new pearl millet varieties displayed prospects for cultivation in Namibia with promising yields under the Namibian soil and climatic conditions under a rainfed production system.

Therefore, to stimulate the development of high-yielding adapted pearl millet varieties that feed into the mainstream seed and food production systems, we recommend the following specific interventions:

a) The NAB/UNAM should import the top best three overall performing new pearl millet varieties (SOSAT C88, IP 17645 & IP 198948) that can be planted on at least one ha for seed multiplication to initiate seed bulking. Varieties IP 16754, ICMP 177003, MS 11, and MS 2 should be introduced to further breeding research for future observation.

b) The NAB/UNAM should submit the pearl millet field trial yield performance results to the Ministry of Agriculture, Water and Land Reform (MAWLR) for variety approval as per the Seeds and Seed Varieties Act 23 of 2018.

c) The MAWLR needs to implement the Seed and Seed Varieties Act 23 of 2018. This will facilitate the introduction of the best new pearl millet varieties to create better varietal selection options for farmers and increase local pearl millet production and productivity in Namibia.

d) The NAB/UNAM should introduce these best-performing varieties to local farmers for mass production through the MAWLR.

e) The NAB/UNAM should start with seed bulking by conducting the trials on at least one hectare per trial site.

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