Adaptation of new superior rice varieties at the altitude of 1600 masl in Jayawijaya Papua

Arifuddin Kasim, Pandu Laksono, Merlin K. Rumbarar and M. Thamrin
Balai Pengkajian Teknologi Pertanian Papua
Jl.Yahim No.49 Sentani – Jayapura 99352, Papua
Email: bptppapua@yahoo.com

Abstract. Adaptation of new high yielding highland rice varieties in Jayawijaya Regency, Papua Province. The research was carried out from June to September 2017 in Jayawijaya, Papua. The aims were to determine the appearance and productivity results of new high yielding rice varieties at an altitude of 1600 m above sea level. The study used a Randomized Block Design and each treatment was repeated 4 times. There were 4 (four) new superior varieties tested and one local variety as a comparison. Inpari 26, Inpari 27, Inpari 28 and Sarinah have been used for the treatment while the comparison variety was existing varieties (local Toraja). Component of growth and a component of production were collected as the parameter. The results showed that the superior variety of Inpari 28 provided the highest adaptability and yield which obtained 4.94 t / ha (MPD) and the age of the pan was also faster than other varieties. It showed the deepest age was obtained by local varieties 190 days after spread.

1. Introduction
Superior varieties play an important role in increasing the yield of lowland rice. Variety as a component of production has contributed about 65%, and therefore one of the main tipping points for increasing rice production. The potential of lowland rice according to the Agency for Agricultural Research and Development based on several studies of adaptation of superior varieties is able to reach 10 t/ha with the application of innovative technology. In general, technological components that affect rice productivity and efficiency in the use of inputs under various geographical conditions include the use of quality seeds, location-specific new varieties, young seedlings, legowo row system and balanced fertilization [1, 2].

The ecosystem of highland rice fields in Indonesia reaches 17% of the total area of rice fields [3]. It is estimated that there are 1 - 1.3 million hectares of rice fields in Indonesia at an altitude above 700 m above sea level, spread in the Bukit Barisan Mountains in Sumatra, in the Hills of West Java, Central Java, East Java, Nusa Tenggara, Sulawesi and Papua [4], [5]. Productive rice fields are reported to be only around 500 thousand hectares, mostly in Sumatra, South Sulawesi and Papua [6], [7], [8]. Meanwhile, according to IRRI documents, it was reported that the total area of upland rice fields in Indonesia reached 14% of the total area of existing paddy fields or reaching 1.3 million hectares spread across Java, Sumatra, Kalimantan, Sulawesi, Papua and other islands [9].

The main problem in the development of upland rice production is low-temperature stress [10], [11]. The most widely grown rice in Indonesia is Japonica Subspecies, which is known to be less tolerant of low temperature stresses, whereas Japonica Subspecies which are widely grown in China, Japan and Korea are known to be more tolerant of low-temperature stresses especially in the
germination phase besides being more tolerant of drought [10], [12], [13]. In Indonesia, a number of local highland rice varieties are known, including Sarinah, Pulu 'Mandoti, Pinjan and Lambau [8]. Weaknesses of these varieties are low production and long-lived and cannot be used as a source of seed development [14].

Jayawijaya Regency is one of the regions located in the central mountain region with an altitude of 1600-2000 meters above sea level with an area of 52,916 km² [15]. Based on the identification and characterization of AEZ from the area, the suitable land for paddy rice plants is around 500 ha spread over four districts. Rice productivity in Jayawijaya Regency ranges from 2.7 to 3.5 t / ha. Grain yield is relatively low compared to other highland rice production, which averages 4-6 tons/ha.

The low rice production in Jayawijaya regency is due to the varieties planted by farmers, generally, local Toraja varieties whose harvest age is 190 HSS, so the farmers only plant once a year. In its place of origin, the Tanah Toraja plateau, there are several local varieties planted with various characteristics including black, red, aromatic and fluffier rice [16]. Therefore, the introduction of superior varieties that are resistant to low-temperature stress is one of the strategies to develop upland rice [7].

Increased productivity can be done by introducing adaptive new superior varieties. Superior varieties in an area may not necessarily give the same results when planted in other areas especially with different heights and different temperatures due to interactions between genes in rice plants and the growing environment [17], [18]. In addition, plants will also respond to changes in gene expression patterns when they are at low temperatures, and adaptability has an impact on plant endurance to stay alive and affect yields [19]. Productivity is an indicator of superior varieties in their ability to adapt to their environment. The purpose of the study was to determine the level of adaptation of new highland rice varieties adopted by the Agency for Agricultural Research and Development at an altitude of 1600 meters above sea level in the Jayawijaya highlands, Papua.

### 2. Materials And Methods

The activity was located at Kohisilapok Village, Hubikosi District, Jayawijaya Regency, Papua Province at an altitude of 1600 m asl, with the area of 0.5 ha starting in June - October 2017. The study used a Randomized Block Design (RBD) with four replications. The treatment uses 4 VUB namely: Inpari 26, Inpari 27, Inpari 28, Sarinah and Toraja Local existing varieties. The rice seeds used are the main seeds (Stock Seed) obtained from the Central Rice Paddy, while the existing varieties (local Toraja) are obtained from local farmers. The technological components used are shown in Table 1.

| Table 1. The components of integrated crop management technology applied in Jayawijaya Regency on 2017 |
|---|---|
| Description | Technological components |
| 1. Tillage | Complete, build-up drainage |
| 2. Varieties | Inpari 26, Inpari 27, Inpari 28, Sarinah |
| 3. Seed Needs | 25 kg/ha |
| 4. Age of seedlings | 20 Days after seeding |
| 5. Number of plants/holes | 2-3 plants/cluster |
| 6. Spacing | Legowo 4:1 50 cmx (25cm x 12,5 cm) |
| 7. Fertilizer | Organic (manure 1,5 t/ha) dan liquid organic fertilizer |
| 8. Pests and diseases control | Natural pesticide |
| 9. Weeding | Manual, without herbicide |
| 10. Harvest and post-harvest | On time, without agricultural machinery |

The parameters observed were plant height, flowering age, the maximum number of tillers, panicle number, panicle length, number of seeds per panicle, vacuum per panicle, weight of 1000 grains, MPD production. Agronomic data were analyzed statistically using analysis of variance (Anova) and to find
out the difference between treatments, Duncan Multiple Range Test (DMRT) was performed at the 5% level [20].

3. Results And Discussion

3.1. Components of plant growth

Inpari 26, Inpari 27, Inpari 28 and Sarinah are new released by the Indonesia Agency for Agricultural Research and Development which have the ability to adapt to highland ecosystems. Upland rice VUBs have characteristics including shorter plants, higher productivity than highland local varieties, and tolerance to low-temperature stress (Table 2).

| Description          | Variety       | Inpari 26 | Inpari 27 | Inpari 28 | Sarinah |
|----------------------|---------------|-----------|-----------|-----------|---------|
| Plant age            |               | ± 124 das | ± 125 das | ± 120 das | ± 125 das |
| Plant form           |               | Erect     | Erect     | Erect     | Erect   |
| Plant Height         |               | ± 80 cm   | ± 81 cm   | ± 97 cm   | ± 116 cm |
| Warna Gabah          |               | Clear Yellow | Clear Yellow | Clear Yellow | Clear Yellow |
| Loss                 |               | Moderate  | Moderate  | Moderate  | Easyly loss |
| Topple               |               | Tolerant  | Tolerant  | Tolerant  | - |
| Rice texture         |               | Soft, tasty | Soft, tasty | Soft, tasty | Soft, tasty |
| Amilose              |               | ± 20,9%   | ± 21,8%   | ± 23,7%   | ± 23,3% |
| Weight per 1000 seed |               | ± 26.5 gr | ± 26.7 gr | ± 27.4 gr | ± 25.5 gr |
| Production average   |               | 5.7 ton/ha | 5.7 ton/ha | 6.6 ton/ha | 6.98 ton/ha |
| Yield potency        |               | 7.9 ton/ha | 7.6 ton/ha | 9.5 ton/ha | 8 ton/ha |
| Planting suggestion  |               | Highland rice | Highland rice | Highland rice | Highland rice |
|                      |               | fields up to 900 m | fields up to 900 m | fields up to 1100 m | fields |
| Release year         |               | 2012      | 2012      | 2012      | 2006    |

Source: [21]

Observation of 50% flowering age of the four VUBs was not significantly different from the existing varieties. The flowering age of rice VUB is dominant faster than the existing local variety of Toraja. The fastest flowering age is Inpari 28 (70 DAS) and the slowest existing varieties (3). Likewise, with the age of harvesting the faster the flowering, the age of the harvest is also faster. The earliest time to harvest is inpari 28 and the slowest is local varieties. The adaptation test of several superior varieties in the Jayawijaya highland shows the flowering age of Sarinah, Batang Lembang, Semeru Tinggi, Aek Sibundong, Batang Pianam and Situbagendit varieties ranging from 90 - 97 DAS [22]. Furthermore, the results of the adaptation test of Inpari 27 and Inpari 28 varieties in the highlands of North Lore Poso Regency at an altitude of 1,108 m asl, the ages of the two varieties reached 127 masl and 124 masl [23]. The harvest age of Inpari 28 and Sarinah varieties planted at an altitude of 850 m asl reached 127 das and 125 das [24].

The height of rice VUB plants tested ranged between 65.36 - 82.5 cm, the highest plants obtained were the existing varieties (148.76 cm) and significantly different from the three VUBs. The lowest variety was in Inpari 27 (65.36 cm). The plant height of each VUB is lower than the description 80 - 116 cm. This is because this research is located at an altitude of 1600 m above sea level so that it affects the solar radiation and temperature. The higher the place, the lower the temperature difference in plant height can be caused by the composition of genes and genotypes of plants that are different from each variety [17], [24]. Rice plant height was also affected by transplantation time, soil and water
conditions, and how to plant and how to spread seeds [25]. Plant height was negatively correlated to yield, but positively correlated to seed quality [26]. Local varieties exhibit the dominant character of upland rice which generally has a prototype of tall plants, although it is still shorter than some local Toraja varieties that are planted in their original places reaching 164 cm [16]. Inpari 28 and Sarinah varieties planted at an altitude of 850 m above sea level, obtained plant heights of 88.3 cm and 80.8 cm respectively, not far from the description of each variety [24].

The maximum number of tillers per VUB family with existing varieties was not significantly different, but the highest number of tillers was produced by Inpari 28 varieties, followed by Inpari 27, Sarina and Inpari 26. The least number of tillers produced by existing varietal. The three VUBs tested were well adapted to altitude in Jayawijaya. The number of productive tillers affects the number of panicles produced and can be directly proportional to the amount of grain produced.

Analysis of the various components of growth in flowering age, harvest age, the maximum number of tillers and plant height showed that VUB treatment of lowland rice had different effects (Table 3).

**Table 3.** The average plant height, flowering age, harvest age, and number of tillers in Kasilapok village, Hubikosi Jayawijaya district, 2017

| Rice    | Flowering ages (days) | Harvest age (days) | Plant Height (cm) | Panicle (cm) |
|---------|-----------------------|-------------------|------------------|--------------|
| Sarinah | 105<sup>m</sup>        | 160<sup>m</sup>   | 76,64<sup>bc</sup> | 21,30<sup>m</sup> |
| Inpari 26 | 75                     | 145               | 70,55<sup>cd</sup> | 19,89         |
| Inpari 27 | 80                     | 155               | 65,36            | 26,11         |
| Inpari 28 | 70                     | 143               | 82,8<sup>b</sup>  | 23,08         |
| Lokal   | 115                    | 190               | 148,76<sup>a</sup> | 18,11         |

**Ket:** The value in each column followed by the same letter means that it is not significantly different at the 5% level of the DMRT test.

### 3.2. Components of crop production

Analysis of various components of crop production, panicle length, number of filled grains, weight of 1000 grains, and yield showed that the VUB treatment had a significant effect on panicle length and number of filled grains, while the weight of 1000 grains and yield did not significantly differ (Table 4).

**Table 4.** Average panicle length, number of filled grains per panicle, the weight of 1000 contents per panicle and Yield of dried milled grain per ha in Jayawijaya 2017

| Varietas | Panicle length (Cm) | Σ number of filled grains (grain) | Weight of 1000 grains (gr) | Yield of grain (t/ha)GKG |
|----------|----------------------|---------------------------------|----------------------------|--------------------------|
| Sarinah  | 23,38<sup>b</sup>    | 122,11<sup>a</sup>              | 25,28<sup>bc</sup>         | 2,06<sup>ab</sup>        |
| Inpari 26 | 23,94<sup>b</sup>    | 109,97<sup>bc</sup>             | 24,94                       | 3,18                     |
| Inpari 27 | 21,52<sup>c</sup>    | 91,58<sup>b</sup>               | 24,63                       | 2,51                     |
| Inpari 28 | 23,80<sup>b</sup>    | 117,77<sup>ab</sup>             | 25,01                       | 4,94                     |
| Lokal    | 28,49<sup>a</sup>    | 137,22<sup>a</sup>              | 29,51                       | 5,03                     |
| Lokal    | 3,84                 |                                 |                            |                          |

**Note:** The number followed by the same letter in the same column is not significantly different at the level of 0.05% DMRT Test.

New superior varieties of panicle lengths range from 21.52 cm - 23.80 cm significantly different from the existing varieties. Between Inpari 26 varieties, Inpari 28 and Sarina were not different but significantly different from Inpari 27. The longest panicle was obtained with existing varieties of 28.49 cm then followed by Inpari 26, Inpari 28, Sarina and Inpari 27 respectively (23.94 cm, 23.80 cm, 23.38 cm), while the shortest panicle was obtained in Inpari 27 (21.52 cm). The variation of
Panicle length is more dominated by genetic factors (79%) compared to the influence of environmental factors (21%) based on heritability [14].

The number of filled grains per panicle was significantly different, where the most filled grain was obtained by existing varieties (137.22 grains) but not significantly different from Sarina and Inpari 28. The least amount of filled grains produced was Inpari 27 variety, 91.58 grains. The weakness of superior varieties during low-temperature stress is panicle fertility which is lower than local varieties with deep age [11]. Low temperature conditions can affect the physiology of rice plants which will have a negative impact on plant growth including being able to inhibit the vegetative growth phase, the flowering phase which results in low panicle fertility and grain quality in grain production, resulting in increased longevity of harvest [27]–[29]. Effect on seedling growth, causing yellow leaves (leaf discoloration), small number of tillers, slowing flowering time, abnormal panicle exertion, increased panicle sterilization, maturation panicles are irregular, and cause a decrease in yield [19].

On the calculation of 1000 grain weight show that local varieties have heavier weights (29.51 g) compared to other varieties. Meanwhile, upland superior varieties in the range of 24.63 - 25.28 grams and is lower than the description in (Table 2). The highest production of superior varieties was obtained by Inpari 28, which was 4.94 tons/ha of dry milled grain, and the lowest was Sarinah (2.06 t / ha). The results of Existing local variety is reached 5.28 tons/ha which is higher than the four superior varieties.

Adaptation tests in several highland areas show that New Superior Varieties of highland adapted-rice have higher productivity compared to local varieties. The adaptation test of highland rice VUB (Inpari 16, Inpari 23, Inpari 24, Inpari 27 and Inpari 28) in the North Lore highlands (1,108 meters above sea level), Poso Regency, Central Sulawesi gave higher productivity compared to local varieties (Superwin and Kamba) with difference in yield ranging from 2.8 tons to 5.71 tons / ha harvested dry grain, where Inpari 16 and 24 give the highest yields of 7.71 t / ha and 7.50 t / ha while local varieties obtain 3 t / ha and 2 t / ha [23]. Study of several highland rice VUB varieties of Inpari 21, Inpari 28 and Batang Piaman in the Sungai Tinggi Jambi highlands (500-1000 masl) obtained productivity of 5.8 t / ha, 7.6 t / ha and 6.62 t / ha [2].

The local rice variety of Toraja in its place of origin has characteristics such as a distinctive aroma, fluffier, resistant to pest and disease and has adaptability at an altitude of 700-2000 m above sea level [14]. Toraja local dry milled grain production ranges from 2.53 to 6.53 t / ha [16] and according to other studies toraja rice productivity between 4.46 - 6.63 t / ha [14]. Meanwhile in Jayawijaya, toraja local rice productivity ranged between 1.2 - 1.85 t / ha [22].

4. Conclusion

New superior varieties of Inpari 28 and Inpari 26 produce early maturity of 143 and 145 DAS, thereby can be used to increase rice index production up to twice a year in Jayawijaya district. Inpari 28 superior variety is adaptive in specific environments with the highest yield of 4.94 t/ha dry milled grain which is able to develop in Jayawijaya district.

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